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Environmental and Safety Designs, Inc.

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Memphis, TN • Nashville, TN • Raleigh, NC • Pensacola, FL • North Charleston, SC

August 26, 1994

Beth Brown
Remedial Project Manager
United States Environmental
Protection Agency
345 Courtland St., NE
Atlanta, GA 30365

Re: Groundwater Remedy Design, Carrier Air Conditioning Superfund Site, Collierville,
Tennessee

Dear Ms. Brown:

Environmental and Safety Designs is pleased to submit three copies of the Groundwater Remedy Design Report for the Carrier Air Conditioning Superfund Site, Collierville, Tennessee for your review.

If you have any questions or comments, please contact me at 901/372-7962.

Sincerely,

Environmental and Safety Designs, Inc.

A handwritten signature in blue ink that reads 'Darrell Richardson'.

By: Darrell Richardson
Environmental Engineer

Enclosures

cc: Mr. Nelson Wong, Carrier Corporation
Ms. Sharon Everett, TDEC



GROUNDWATER REMEDY DESIGN

Prepared for:

**Carrier Corporation
97 South Byhalia Road
Collierville, Tennessee 38017**

Prepared by:

**Environmental and Safety Designs, Inc.
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August 25, 1994

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1.0 INTRODUCTION

This document presents the design for remediating trichloroethene (TCE)-contaminated groundwater in the Memphis Sand aquifer at the Collierville site.

On July 15, 1986, the Town of Collierville's west well at Water Plant 2 was sampled by the Tennessee Department of Health and Environment [now referred to as Tennessee Department of Environment and Conservation (TDEC)], and found to contain TCE. In addition to the Town of Collierville's Water Plant 2, 15 private wells were identified by TDEC within three miles of the site. Analyses of these wells by TDEC in September and October, 1986 were negative for TCE to a detection limit of 0.1 $\mu\text{g/L}$.

In 1990, Carrier and the Town of Collierville designed and installed an air-stripping tower system at Water Plant 2 to treat contaminated groundwater that had reached the Memphis Sand aquifer. This 1.5 million gallons/day (mgd) system removes TCE from raw water before it enters the chlorination system and allows the town to use Water Plant 2 fully. The treatment system was designed to handle incoming TCE concentrations of up to 300 micrograms per liter ($\mu\text{g/L}$). Water Plant 2 is monitored for volatile organic compounds, lead and zinc, and initially was monitored more frequently.

A Performance Standards Verification Plan (PSVP) (Appendix A) has been developed to serve as a guidance on sampling activities throughout the operation and maintenance period of this project, and describes the activities which will ensure performance standards are being met. Contaminant cleanup levels and groundwater restoration are also discussed in the PSVP.

This design document re-transmits the design of the Water Plant 2 production and treatment system. Groundwater monitoring during remedial design has shown that this plant will maintain capture (i.e. contain) the plume of TCE documented to exist during the Remedial Investigation (RI).

2.0 DESIGN ANALYSIS

The groundwater remedial objective is to eliminate or reduce risks posed by the Collierville site, through treatment, engineering, and institutional controls. Groundwater containment and treatment shall be conducted at Water Plant 2. The existing air strippers at Water Plant 2 shall continue to be used to treat extracted groundwater.

The stratigraphic investigation conducted during the RI indicates shallow groundwater eventually will migrate to an area where the Memphis Sand aquifer and the shallow aquifer unit are hydraulically connected. To prevent contaminants from migrating further into the Memphis Sand aquifer from shallow groundwater, a soil vapor extraction (SVE) system has been installed at the North Remediation Site (NRS) and a second will be installed at the main plant area.

2.1 Containment of Contaminated Groundwater

Groundwater is currently being extracted from the Memphis Sand aquifer from the two Town of Collierville wells (located at Water Plant 2), the wells are designated as City Well East (CWE) and City Well West (CWW). The daily production rate from the two wells has recently averaged better than 750 gpm (1.1 mgd).

Two downgradient MWs (MW-60 and MW-62) were installed in May and June, 1994 to obtain hydraulic data beyond what was available from existing MWs and the two production wells. They also serve as detector wells for water flowing to the west of, or under the capture zone of the two Water Plant 2 production wells. MW-60 was completed to a depth of 385 feet, with a 20-foot screened interval which begins 70 feet below CWEs completion depth and 86 feet below CWWs completion depth. MW-62 was completed to a depth of 200 feet, with a 20-foot screened interval, about 75 feet above the top of the screen in CWE and 39 feet above the top of the screen in CWW.

Groundwater transport modeling was used to compare the potentiometric surface used during initial modeling (to choose the proper downgradient monitoring well location) and to assess groundwater travel times from the source areas at the Collierville site to the newly installed MWs (MW-60 and MW-62). As described in the Technical Memorandum entitled *Site Downgradient Monitoring Well Data Quality Assessment*, each extraction well was initially modeled using a flow rate of 375 gpm or a combined flow rate of 750 gpm. The maximum flow possible from Water Plant 2 is 1.4 mgd, or 486 gpm from each well.

Advective particle tracking was conducted to predict whether TCE contamination has had enough time to migrate from the site of the 1979 TCE spill area at the main plant to the Town of Collierville wells and continue 1,000 feet to MW-60 and MW-62. The model suggests that a particle would reach the Collierville wells in about six years from the main plant source area. Site observations indicate that the spill occurred in 1979 and was first detected in the Collierville wells in 1985, an approximate travel time of six years. These travel times indicate that if Water Plant 2 were not providing containment, MW-60 and MW-62 which are approximately 1,000 feet downgradient of Water Plant 2, would have contained detectable amounts of TCE during the recent sampling event.

Groundwater samples were recently collected from pre-existing MWs 3 and 58, new downgradient wells MW-60 and MW-62, CWE and CWW, and from Water Plant 2 equipment. Results of the sampling event indicate no traces of TCE were detected in either MW-60, 62, or 58. The absence of contamination in these wells indicates capture is maintained at the current combined pumping rate of 750 gpm. MW-3, which is located upgradient of Water Plant 2 and screened in the shallow aquifer, had a TCE concentration of 2,000 $\mu\text{g/L}$.

To continue containing contaminated groundwater in the Memphis Sand aquifer, Water Plant 2 will continue to be operated at a minimum pumping rate of 750 gpm.

2.2 Treatment of Contaminated Groundwater

Description

Untreated groundwater is currently treated by two 60-inch diameter air strippers, each consisting of a steel sump with a 4,500 cubic feet per minute (cfm) blower, three 60-inch diameter by 10-foot packing sections containing 3.5-inch diameter Jaeger Tri-pack packing material, and a 60-inch diameter demister section. Combined raw water is pumped from two well pumps (CWE and CWW) into a 10-inch diameter steel pipe near the equipment pad and enters a combined influent header which splits the flow to the two air strippers. If both pumps are operating, the combined flow is split between the two air strippers, otherwise flow is directed to only one air stripper via a motorized valve mounted in-line with the influent header. Once groundwater has entered the top of the air stripper, it enters a distributor to disperse the water evenly throughout the entire surface area of the packing medium. The water then cascades over the packing material as air blows in through the bottom of the tower. When the air and water interface around the packing, a stripping action takes place and volatile contaminants are removed from the water and enter the airstream. Once the water passes through the entire packing medium, it is gathered in the air stripper sumps. Level controls within the sumps regulate the discharge of treated groundwater.

Model Design

Parameters included for design were based on the operation of one air stripper and are summarized below. The detailed model design is included in Appendix B.

- | | |
|--------------------------|---------------------|
| • Contaminant | TCE |
| • Influent Concentration | 300 $\mu\text{g/L}$ |
| • Effluent Concentration | 1 $\mu\text{g/L}$ |

- Liquid Flow 500 gpm
- Air Flow 4,500 cfm
- Temperature 50 °F
- Packing Material 3.5 inch diameter Jaeger Tri-Pack
- Tower Height 29 feet
- Tower Diameter 5 feet

The system is currently composed of two air strippers and is operating under the following conditions:

- Influent Concentration 35 $\mu\text{g/L}$ average TCE concentration from the east well, and 119 $\mu\text{g/L}$ average TCE concentration from the west well, or a combined average influent concentration of 77 $\mu\text{g/L}$
- Effluent Concentration not detected at a detection limit of 1 $\mu\text{g/L}$
- Liquid Flow combined average of 1.2 mgd from both wells

The influent concentration average shown above includes data from June 6, 1990, to the most recent sampling event. CWW has experienced influent concentrations greater than 200 $\mu\text{g/L}$, while CWE has exhibited influent concentrations greater than 100 $\mu\text{g/L}$. Even under these

unusually elevated TCE concentrations, Water Plant 2 maintained an effluent rate below method detection limits.

As discussed in Section 2.1, to provide total containment of contaminated groundwater, the average combined flow rate from both wells must be maintained at 750 gpm or 1.1 mgd. Monitoring results indicate that the air-stripping system at Water Plant 2 is capable of reducing influent concentrations to below 1 $\mu\text{g/L}$ at a sustained flow rate of 750 gpm or better.

3.0 PLANS AND SPECIFICATIONS

Operation of Water Plant 2

Water Plant 2 is composed of two well pumps, an air-stripping system, aeration tower, chlorine injection, and ground storage tank.

Groundwater is continually pumped from the two wells (CWE and CWW) each using a 20-horsepower (hp), vertical turbine pump rated at 500 gpm. Each pump can be operated by three functions: hand, off, or automatic (HOA). Conditions that may alter operation of either CWE or CWW include: air stripper blower pressure falls below 0.5 inches water column, water in the air stripper sump exceeds 40 inches, or a signal (or signals) from the ground storage tank calling for water or the water elevation in the ground storage tank is at the high level indicating to shut off pumps.

Once groundwater is pumped from the wells, it is routed to a 10-inch diameter combined influent header which splits the flow to the two air strippers depending upon whether both well pumps are running or just one. If both pumps are operating, the combined flow is split between the two air strippers, otherwise flow is directed to only one air stripper via a motorized valve mounted in-line with the influent header. Once pumped water has reached the top of each stripping tower it enters a distributor to disperse the water over the entire surface area of the packing medium. The water then gravity flows through the packing as air blows in through the bottom of each tower, creating a mass transfer of contaminants from a liquid phase to a gaseous phase, where it discharges through the top of the air strippers.

Once the groundwater has passed through the entire packing medium, the water is gathered in the air stripper sumps. The discharge piping of the sumps are tied into one common header so water levels in each sump are always equal even if only one well is pumping. Level controls are mounted on the side of only one of the air stripper sumps. These level controls will activate/deactivate the effluent discharge pumps. A flow control valve is mounted in-line with

the discharge piping, along with a pressure transducer to measure the water level in the sump. The transducer sends the level information to the control panel, which in turn signals a motorized valve, telling the valve how far it should open to maintain a pre-determined level of water in each sump. Thus the level in the sumps is maintained based upon incoming flow rates.

Once treated water has passed through the modulating valve, it is pumped underground into a 1,500-gpm forced draft aeration tower. The aeration tower is used for degassing groundwater. While being injected with chlorine, water is gravity fed from the aeration tower through a 12-inch diameter pipe to a mixing box located in the 300,000-gallon ground storage tank. Finally, two 800-gpm service pumps distribute the final treated water to the distribution system.

Construction drawings for Water Plant 2 (before the air-stripping system's installation) and subsequent to the air-stripping system are included as an attachment to this document. It should be noted that the original Water Plant 2 construction drawings differ from the current system. Table 1 defines these differences and also the minor modifications which have been made since the installation of the air-stripping system.

Table 1 Water Plant 2/Carbonair As-Built Drawings	
Drawing No.	Differences
Sheet 1	Replaced by CC437, with new well/plant connections and piping.
Sheet 2	The current configuration contains air strippers prior to the aerator. The PID drawing in the Carbonair O&M Plan details this configuration.
Sheet 5	The current configuration now contains air strippers and the building which houses the air stripper controls.
CC429	The current configuration contains three 10' 4" packed sections.
CC518	CC518 replaces Sheet 6 with the addition of the air-stripping system pump control.

Control Logic

The control panel provided by Carbonair is equipped with the air stripper system. The HOA switches for the well pumps must be in the auto position to allow them to run when using the Carbonair system.

Water level in the ground storage tank is regulated by 5 water level switches: low water deactivate for the service discharge pumps, service discharge pump activate, CWW pump activate, CWE pump activate, and CWW/CWE deactivate. Once the logic control device receives a signal (or signals) from the level controls in the ground storage tank calling for water, one or both of the air stripper blowers will turn on and also one or both of the motorized valves will open to allow influent water into the air stripper(s). After a 15-second delay, the well pump(s) will be activated. Once a predetermined level is reached in the ground storage tank, a signal sent to the logic control device will deactivate the proper well pump and subsequently shut down the appropriate air stripper influent valve. This action ensures that no water is allowed into an air stripper tower previously shut down.

Two motorized valves open and close to allow influent water to each respective air stripper. These motorized valves also serve as safety devices should the ground storage tank fill up to the CWW/CWE deactivate level. Should only one well pump shut off, the motorized valve for the other air stripper will close, not allowing any raw water enter a deactivated air stripper.

As described earlier, level switches are mounted on the side of one of the air strippers. The bottom switch will stop the air stripper discharge pump and the second switch will start the air stripper discharge pumps. If the air stripper system is not operating, and one of the well pumps calls for water, one of the air strippers will be activated and water will begin being treated. Once the water level in the air stripper sump reaches the air stripper discharge switch, the discharge pump will activate and water will be discharged. If the second pumping well calls for water while the first system is still running, the second stripper will activate and begin treating

and discharging water as described above. If water in the sump reaches the high-level switch, both air strippers will shut down, as well as the well pumps, while the air stripper pumps continue to discharge water from each sump until empty, at which time they will shut down. To ensure that the system is not reactivated, a safety relay will latch and the system cannot be reactivated automatically. Once the cause of the high level is determined, the operator can reactivate the system by pushing the reset button. If needed, the system can be activated manually.

Pressure differential switches on each air stripper act as safety devices if an air stripper blower fails. Should the blower pressure reach a certain level, well pumps and the blowers will be deactivated. Once again, the operator must reactivate the system.

The system will continue to operate normally as long as at least one of the service discharge pumps is operating, a high level is not reached in the air stripper sumps, or the air stripper blowers do not fail. To ensure that both discharge pumps do not fail at the same time, one of the pumps will always be operated manually. Preventive maintenance procedures will be followed on all equipment to ensure no down time of the system.

In 1992, an additional 10 foot of packed height was added to the air-stripping system. During this modification, the packing media was inspected and found to contain no biological or hardness fouling. Packing media will be inspected quarterly for 5 years and then reduced to annually to ensure that fouling is not occurring.

The Operation and Maintenance Plan for the air strippers is included in Appendix C. Appendix D includes the Operation and Maintenance Plan for Water Plant 2.

Appendix A
Performance Standards Verification Plan

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- Measure the depth of the well with a pre-cleaned weighted steel tape.
- Purge at least three well volumes of water. MW-60 and MW-62 will be purged using a pre-cleaned submersible pump and Teflon tubing, and sampled using a pre-cleaned bailer. The pump should be positioned within the upper few feet of the water column to achieve thorough purging. MW-58 will be purged and sampled using the previously installed pump in the well. MW-3 will be purged and sampled using a pre-cleaned bailer. Purged waters will be retained until the regulatory status of the water is determined.

The volume of water in the well casing will be calculated as follows:

$$\text{Volume} = (A - B) \times (C)$$

Where:

V	=	represents the volume in gallons,
A	=	represents the total well depth,
B	=	represents the depth to water level, and
C	=	0.17 for 2" wells or 0.66 for 4" wells

After each purged volume, pH, temperature, and conductivity will be monitored for stabilization. Field measurements will be considered stabilized according to USEPA's Environmental Compliance Branch, *Standard Operating Procedures and Quality Assurance Manual*, Section 6.3—Specific Quality Control Procedures.

- **Stabilization Criteria:**

Temperature	—	within ± 1.0 °C
pH	—	within ± 0.5 standard unit
Conductivity	—	within $\pm 10\%$ from the duplicate

If stabilization has not occurred after three well volumes have been purged, additional water will be purged until readings stabilize. The maximum allowable time between purging and sampling is six hours. If the well has not recovered sufficiently after this time, the well will not be sampled.

- **VOC Analysis:**

VOC samples will be analyzed according to EPA Method 8010 with Contract Laboratory Program (CLP) deliverables package.

Samples for VOC analysis will be gently poured into a clean, pre-labeled, 40 ml vial with a Teflon-lined septum. Pouring should be performed to create a convex meniscus at the rim of the sample vial. The cap should then be applied at an angle and sealed. No air bubbles should be visible once the vial is sealed. If bubbles are visible, the vial should be discarded, and the procedure must be repeated.

- **Inorganics Analysis:**

Inorganic samples will be analyzed according to EPA Method 6010 for the analysis of lead and zinc. Samples for inorganic analysis will be poured into 1-liter polyethylene or glass jars. HNO_3 (nitric acid) will then be added to lower sample pH of below 2. Proper preservation can be checked by pouring a small amount of the sample into a clean cup and checking it with litmus paper.

Samples will then be placed in a cooler containing ice and water in sealable plastic bags, or blue ice, to provide temperature preservation at 4°C. Coolers will be shipped overnight to the laboratory at the end of each work day. All samples to be shipped for analysis will be delivered to the laboratory within 24 hours of collection.

3.0 QUALITY CONTROL SAMPLES

Precision will be assessed by evaluating results of duplicate and matrix spike duplicate samples. Accuracy will be assessed by evaluating field blanks, trip blanks, matrix and surrogate spikes, and reagent blanks and blank spike samples. Table 4-1 summarizes QC sampling frequencies.

Table 3-1 Quality Control Sample Collection Frequencies		
Quality Control Sample	Frequency of Collection	Additional Sample Volumes
Trip Blank (volatiles only)	One per sample shipping cooler containing samples to be analyzed for volatiles	3x40 ml. VOA vials with Teflon-lined septa
Rinsate Blank	Collected every day or every ten samples, but only analyzed every other day.	3x40 ml. VOA vials for VOCs and 1 liter P,G jar for metals
Field Blank	One per sampling event or every ten samples.	3x40 ml. VOA vials for VOCs and 1 liter P,G jar for metals
Duplicates	One per 10 samples per matrix	3x40 ml. VOA vials for VOCs and 1 liter P,G jar for metals
Matrix Spike/Matrix Spike Duplicate Samples	One per 20 samples per matrix; duplicate sample may be used for matrix spike	3x40 ml. VOA vials for VOCs and 1 liter P,G jar for metals*

Notes:

P,G — Polyethylene or Glass

- — Matrix spike/matrix spike duplicate requirements are slightly different for the inorganics analysis. The inorganics analysis will only have one sample to spike, no duplicate spike sample will be necessary.

4.0 EQUIPMENT DECONTAMINATION

All non-dedicated stainless steel sampling equipment will be decontaminated between sample points using the decontamination procedures listed below.

1. Equipment will be washed thoroughly with laboratory detergent (i.e. Liquinox) and followed by a hot water rinse using a brush to remove any particulate matter or surface film.
2. Equipment will be rinsed with potable water to remove any remaining detergent.
3. Following the potable water rinse, the equipment will be rinsed with deionized water.
4. Rinse twice with pesticide-grade isopropanol.
5. Rinse with organic-free water and air dry.
6. Sampling equipment will be wrapped in aluminum foil until ready for use. Non-sampling equipment may be wrapped in plastic to avoid contamination.

Field personnel will don a new pair of disposable nitrile gloves before the handling of sampling equipment for decontamination.

5.0 SAMPLE MANAGEMENT

Sample management will consist of sample labelling, chain-of-custody seals and records, and associated field documentation procedures. The purpose of these procedures will be to ensure the quality of the samples are maintained during their collection, transportation, storage and through analysis to the final data deliverables. All sample management documentation and sample handling protocols have been developed using, as guidance, the EPA Region IV-Environmental Compliance Branch *Standard Operating Procedures and Quality Assurance Manual*, (February 1, 1991) and are discussed below.

Sample Identification Documents:

- Sample label
- Custody seals
- Chain-of-custody records
- Field notebooks
- Corrective Action Documentation

5.1 Sample Labelling

Sample container labels, as shown in Figure 5-1, will be required for identifying each submitted sample. Sample label information will include the site name, sample identification, preservation, required analysis, date of collection with time and the sampler's name. Each label must be printed in a legible manner using waterproof black ink.

Table 5-1 outlines the sample designation system to be used to identify each sample. Should additional sample designations be required, this table will be amended. Additional sampling information including date and time of collection will be provided on the chain of custody (COC).

ENSAFE <i>Environmental and Safety Designs, Inc.</i>	
SITE NAME	DATE
ANALYSIS	TIME
	PRESERVATIVE
SAMPLE IDENTIFICATION	
PROJECT NUMBER	
SAMPLERS NAME	

Environmental and Safety Designs, Inc.

ENSAFE®

5724 SUMMER TREES DR. MEMPHIS, TN 38134 (901) 372-7962

FIGURE 5-1
SAMPLE BOTTLE LABEL

DATE: 04/22/93

DWG NAME: SAMPLABL

Table 5-1 Sample Designation System			
Location	Sample Type	QA Sample Type	Sample Location and Depth
CC = Carrier, Collierville Site	GW = Groundwater S = Soil SD = Sediment BHG = Borehole Vapor Samples IN = Influent EF = Effluent OG = SVE Off Gas SV = Soil-vapor	RB = Rinsate Blank FB = Field Blank TB = Trip Blank DP = Duplicate MS = Matrix Spike MSD = Matrix Spike Duplicate	B = Boring MW = Monitoring Well HA = Hand Auger Boring MP = SVE Monitoring Probe SVW = SVE Well SVE = SVE System GWT = Groundwater Treatment System

Note: Sampling depth or location is based upon a numeric system (ex. sampling interval depth, sampling point along a treatment train)

Examples:

Water Matrix — CC GW MW2 = Carrier Collierville groundwater sample from well 2
 Solid Matrix — CC S B1 = Carrier Collierville soils from boring 1
 Air Matrix — CC OG SVE1 = Carrier Collierville off gas from SVE system at location 1

5.2 Custody Seals

Sample custody seals, shown in Figure 5-2, will be used to ensure that samples are not tampered with during transportation. Custody seals are placed on the shipping containers (and on the samples themselves) in a manner such that the containers cannot be opened without breaking the seal.

5.3 Chain-of-Custody

Chain-of-custody forms, as shown in Figure 5-3, will be fully completed by field personnel and shall accompany the samples during shipment. The form shall contain pertinent information regarding the samples, such as the sampler's name, sample identification, date and time of collection, and description of the cooler's contents (number of sample containers). In addition, information to be relayed to the laboratory shall be written in the "Remarks" section of the chain-of-custody, e.g. a sample accompanied with this chain-of-custody requires quicker attention for analysis. For chain-of-custody purposes, all QC samples are subject to exactly the same custodial procedures and documentation as real samples.



ENVIRONMENTAL AND SAFETY DESIGNS, INC.
5724 Summer Trees Dr.
Memphis, Tennessee 38134

OFFICIAL SAMPLE SEAL

SAMPLE #

DATE

SEAL BROKEN BY

SIGNATURE

DATE

PRINT NAME & TITLE

Environmental and Safety Designs, Inc.



5724 SUMMER TREES DR. MEMPHIS, TN. 38134 #C901X372-7962

FIGURE 5-2
SAMPLE SEAL

DWG DATE: 04/22/93

DWG NAME: SECSEAL



PAGE _____ OF _____

[illegible][illegible]

RELINQUISHED BY:	DATE	RECEIVED BY	DATE	RELINQUISHED BY:	DATE	RECEIVED BY	DATE
SIGNATURE _____		SIGNATURE _____		SIGNATURE _____		SIGNATURE _____	
PRINTED _____		PRINTED _____		PRINTED _____		PRINTED _____	
COMPANY _____	TIME	COMPANY _____	TIME	COMPANY _____	TIME	COMPANY _____	TIME
REASON _____		REASON _____		REASON _____		REASON _____	

METHOD OF SHIPMENT: _____	COMMENTS: _____ _____ _____ _____	AFTER ANALYSIS, SAMPLES ARE TO BE:
SHIPMENT NO. _____		<input type="checkbox"/> DISPOSED OF (ADDITIONAL FEE)
SPECIAL INSTRUCTION: _____		<input type="checkbox"/> STORED (90 DAYS MAX)
_____		<input type="checkbox"/> STORED OVER 90 DAYS (ADDITIONAL FEE)
_____		<input type="checkbox"/> RETURNED TO CUSTOMER

Upon transfer of custody, the chain-of-custody form will be signed by an EnSafe representative, who also notes the date and time. Because common carriers will not sign chain-of-custody forms, the chain-of-custody records will be sealed within each cooler. All chain-of-custody forms received by the laboratory must be signed and dated by the laboratory sample custodian and returned to EnSafe following receipt or as part of the data reporting package.

5.4 Daily Logs (Field Log)

All samples will be documented in accordance with the EPA SOP/QAM, Chapter 3 - Sample Control, Field Records and Document Control. Sampling personnel will use bound, ruled or gridded logbooks with sequentially numbered waterproof pages for activity documentation pertaining to the project. These logbooks will be the master reference for all site activities and accomplishments. These records will also document all visual observations, calculations and equipment calibrations. The logbooks are accountable documents that will be properly maintained and retained as part of the project files.

Each logbook will have labeled on the front cover as follows:

Site name (Carrier Site RD, Collierville, TN)

EnSafe

Sampler's name

Book number (sequentially numbered by distribution or as assigned by the QAO)

Starting and completion dates

The logbook must be labeled with indelible black ink. The following steps shall be followed when making entries into the field logbook:

- Enter the date and time the task begins, weather conditions, and the names and titles of individuals involved in the task. When possible, include the names and titles of personnel visiting the task area.

- Describe all activities in detail and list which forms were used to record such information (e.g. boring logs, field change request forms). It is considered good practice to duplicate the most important information throughout the field logbooks.

Examples of some pertinent information for specific activities are as follows:

- Well installation activities: document the elevations, reference elevations, total depth, size and length of casing and screen, casing and screen material, screen-slot size, drilling conditions and rate and details on the soil lithology. Include any calculations, for example in determining well volumes.
 - Installation of soil boring activities: document the size and depth, sampling equipment used and methods used, details on the soil lithology and the samples collected.
 - Groundwater sampling activities: document weather conditions, members of sampling team, purge volumes, sample analysis, method number.
 - Levels of PPE worn by the sampling team. If the PPE levels are changed for any reason, state the change in protection and the reasons for the change.
- Describe in detail any field tests that were conducted (e.g. PID/OVA measurements) and reference any forms or data records used. Document the results, if obtainable in the field.
 - Describe in detail how the samples were collected or how the blanks/duplicates were prepared. List all label information, sample containers and volume, preservation, packaging, chain-of-custody form number and analytical parameters applicable to each sample. Also, note the time of transfer, and if possible the name of the individual to whom custody was transferred.

- List the equipment type, serial or identification number, time and procedures used, calibration records or logs used, and equipment failures or breakdowns that occurred. Also, include the changes, repairs and results of the equipment failure or breakdown.

5.5 Corrections to Documentation

Notebooks — As with any data logbooks, no pages may be removed for any reason. If corrections are necessary, these must be made by drawing a single line through the original entry (so that the original entry can still be read) and writing the corrected entry alongside. The correction must be initialed and dated. Some corrected errors will require a footnote explaining the correction. Corrections to errors shall be made by the individual responsible for the entries in the field logbook.

Sampling Forms — As previously stated, all sample identification tags, chain-of-custody records, and other forms must be written in indelible black ink. None of these documents are to be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. If an error is made on a document, the individual responsible for preparation of the document may make corrections by crossing a single line through the error and entering the corrected information. Any subsequent errors discovered on a document should be corrected by the person who made the entry. All corrections must be initialed and dated.

5.6 Corrective Action

During the course of any investigation, field personnel are responsible for seeing that field instruments and equipment are functioning properly and that work progresses satisfactorily. The field personnel are also responsible for ensuring performance of routine preventive maintenance and quality control procedures. If a problem is detected by field personnel, the project manager shall be notified immediately. Similarly, if a problem is identified during a routine audit by the project QA officer or the regulatory QA officer an immediate investigation will be undertaken and corrective action deemed necessary will be taken as early as possible.

5.7 Out-of-Control Situations

Potentially out-of-control situations include field instrument breakdown, mislabelling or loss of samples, inadvertent contamination of samples, or circumstances which preclude performance of field activities in accordance with the QAP (or other work plan documents). If an out-of-control event occurs, field sampling personnel shall make appropriate contacts and document any remedial efforts taken to bring field activities under control. The immediate contacts shall be the EnSafe project manager and/or the EnSafe QA officer. The EnSafe project manager shall decide whether further contacts are to be made to Carrier, EPA or the TDEC. Formal documentation of out-of-control occurrences and any associated corrective actions recommended or initiated shall be written on the EnSafe Field Change Request Forms. Field personnel shall also record out-of-control occurrence in the field logbooks.

All variances or changes from project QAP are subject to approval by the EPA remedial project manager (RPM) and the TDEC representative. If circumstances arise which require significant changes in the protocols, methods, or techniques outlined in the work plan and/or the QAP, the EPA RPM and/or the TDEC project manager may be contacted. Any EPA or TDEC alterations will be documented and implemented with the agencies written consent.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

EnSafe personnel will calibrate all field instrumentation in accordance with manufacturer's recommendations. All equipment calibration and/or standardization procedures will be recorded in the field logbook and equipment logs. Calibration records will be maintained at the home office in Memphis, Tennessee.

Records shall include the source of the field standards with lot numbers and expiration dates, and a brief description of the procedures used. When necessary, procedures will be recorded step-by-step into the records. Field equipment calibration is summarized in Table 7-1.

Table 6-1 Field Equipment Calibration		
Equipment/Measurement	Calibration Method	Frequency
pH	2 standard solutions	daily
Temperature	Compared to NBS certified thermometer	quarterly
Conductivity/pH/Temperature Meter	2 or 3 standard solutions (function specific)	weekly, daily if necessary

7.0 PREVENTIVE MAINTENANCE

Sampling equipment which may require preventive maintenance will be checked for proper operation before and after use on a daily basis. Any replacements of parts or repairs will be in accordance to the manufacturer's operations manual or the parts will be sent to the manufacturer for repairs. Records of calibration and maintenance activities for each piece of equipment are contained in logbooks assigned to the equipment. The preventive maintenance program for all laboratory equipment will be handled solely by the laboratory's personnel in accordance with the laboratory's Quality Assurance Plan. Equipment or instruments potentially requiring preventive maintenance are listed in Table 8-1.

Table 7-1 Field Testing Equipment			
Item	Manufacturer	Model #	Serial #
Conductivity Meter	Myron L	pDS	0460222E
pH Meter	Fisher	Accumet 956	3218
Photoionization Detectors	Photovac	TIP II	2580147
	HNu	PI 101	—

Note: The actual make and model of each above instrument may be substituted by a similar model.

Preventative maintenance procedures for sampling equipment which are routinely serviced are described below.

Conductivity Meters

Weekly: Meter probes are cleaned before and after each use with distilled/deionized water. Weekly, the instruments are checked with a commercial conductivity standard for proper calibration. The battery is checked for proper charge.

Quarterly: The instrument is inspected on a quarterly basis, whether used during the quarter or not. The inspection consists of a general examination of the electrical system (including batteries) and a calibration check. Instruments not functioning properly are shipped to the manufacturer for repair and calibration.

pH Meters

Weekly: The probe shall be checked for cracks in the electrode bulb and completely filled with electrolyte solution. At the beginning and end of any sampling day, the pH meter must be calibrated using standard pH buffers of an acceptable range (4.0-7.0 or 7.0-10.0). The battery is checked for proper charge. Following each measurement, the probe is rinsed with deionized water. The probe cap is filled with electrolyte solution and placed on the probe tip. Excess electrolyte is rinsed off and the probe dried with a paper towel. The instrument is then placed in its carrying case.

Quarterly: The instrument is inspected on a quarterly basis whether or not it has been used. The inspection consists of a general examination of the probe, wire, electrical system (battery check) and a calibration check. Any malfunctioning equipment is returned to the manufacturer for repair and recalibration.

Thermometers

Weekly: Before each use, thermometers are visually checked for cracks and mercury separation. After use, thermometers are rinsed with deionized or distilled water and placed in their protective case to prevent breakage.

Monthly: Thermometers are visually inspected as described above, whether used or not. They are checked against an NBS-certified thermometer for accuracy.

Photoionization Detectors

Each use: The TIP II and HNu are zeroed and calibrated using TCE span gas for the TIP II and isobutylene (benzene mimic) for the HNu, at a minimum of before and after each sampling day. Also, to be checked after each use will be the battery for a proper charge, cleanliness of the UV lamp window and the dust filters.

Quarterly: The instrument is inspected quarterly whether or not it has been used. The instrument bulb will be cleaned monthly or more frequently as needed. The inspection consists of a general examination of the probe, wires, electrical system (esp. battery check) and a calibration check. Any malfunctioning equipment is returned to the manufacturer for repair and recalibration.

8.0 MONITORING AND REPORTING SCHEDULE

Following is a schedule of the monitoring and reporting of groundwater monitoring wells and Water Plant 2 used to demonstrate compliance with the Performance Standards. Groundwater samples will be collected from existing wells MW-3 and MW-58; new wells MW-60 and MW-62; the east and west Collierville wells; and from Water Plant 2 equipment (effluent from the air strippers).

The groundwater monitoring wells and Water Plant 2 will be monitored quarterly for one year, then annually thereafter. As stated in Section 1.0, Water Plant 2 raw water will be expanded to quarterly monitoring once Carrier and EPA determine that well-head concentrations have begun to sufficiently decline. Following sampling of the monitoring wells and Water Plant 2, a report will be developed documenting sampling activities and results.

Carrier Collierville

GW/Water Plant 2 Sampling

As of August 14, 1994

Task Name	Start Date	End Date	1994	1995	1996	1997
MW-3, 58, 60, 62 SAMPLING	1-Jul-94	20-Jul-97				
3rd Quarter 94 Sampling	1-Jul-94	30-Sep-94				
4th Quarter 94 Sampling	1-Oct-94	31-Dec-94				
1st Quarter 95 Sampling	1-Jan-95	31-Mar-95				
2nd Quarter 95 Sampling	1-Apr-95	30-Jun-95				
3rd Quarter 95 Sampling	1-Jul-95	30-Sep-95				
1st Annual Sampling Event	10-Jul-96	20-Jul-96				
2nd Annual Sampling Event	10-Jul-97	20-Jul-97				
WATER PLANT 2 SAMPLING	1-Jul-94	31-Dec-95				
3rd Quarter 94 Sampling	1-Jul-94	30-Sep-94				
4th Quarter 94 Sampling	1-Oct-94	31-Dec-94				
1st Quarter 95 Sampling	1-Jan-95	31-Mar-95				
2nd Quarter 95 Sampling	1-Apr-95	30-Jun-95				
3rd Quarter 95 Sampling	1-Jul-95	30-Sep-95				
4th Quarter 95 Sampling	1-Oct-95	31-Dec-95				
REPORTING	31-Oct-94	2-Sep-97				
3rd Quarter 94 Report	31-Oct-94	13-Nov-94				
4th Quarter 94 Report	31-Jan-95	13-Feb-95				
1st Quarter 95 Report	1-May-95	14-May-95				
2nd Quarter 95 Report	31-Jul-95	13-Aug-95				
3rd Quarter 95 Report	31-Oct-95	13-Nov-95				
1st Annual Report	20-Aug-96	2-Sep-96				
2nd Annual Report	20-Aug-97	2-Sep-97				

Appendix B
Air Stripper Modeling Results

Customer :Carrier Corp

B-1

Components		Mol Wt (wtm)	Henry's Const (Hc)	Mol Vol (vb)	Vap Press (pv) mmHg
#1 trichloroethylene		131.5	0.2564	0.1071	34
#2 ERR		ERR	ERR	ERR	ERR
#3 ERR		ERR	ERR	ERR	ERR

	Solub (cs) ug/l	Boil Pt (Temp B) deg K	Inflnt Conc (CI) (ug/l)	Efflnt Conc (CE) (ug/l)	Percent Removed	Equil Conc (CS) (ug/l)
#1	1000000	360	300.0	1.00	99.67	16.66
#2	ERR	ERR	ERR	ERR	ERR	ERR
#3	ERR	ERR	ERR	ERR	ERR	ERR

	Oper Temp (temp) deg K	Oper Press (pres) atm	Liquid Visc (vl) Kg/msec	Gas Visc (vg) Kg/msec	Liquid Dens (dl) Kg/m3	Gas Dens (dg) Kg/m3
	283	1	0.0013	0.00002	1002.4	1.2468

Packing Parameters

Type	Jaeger Tripacks - 3.5" dia
Factor (cf)	12.000
Surf Area (at)	124.600 m2/m3
Diameter (Dp)	0.089 m
Wetted Are (aw)	70.702 m2/m3
Surf Tnsn (stc)	0.033 N/m
Coefficient	

Liquid Flow (qw) m3/s	Air Flow (qa) m3/s	Liquid Load (ml) Kg/m2s	Air Load (gm) Kg/m2s	Press Diff (presd) N/m2/m	Air-to-Water Ratio (vq)
0.031545	2.208	17.344	1.510	90	70

||
500 gpm

||
4500 gpm

500 gpm

300 ppb

29.9' Tower height

5.0 Tower Diameter

B-2

Customer :Carrier Corp

	Liquid Diff (difl) m2/s	Gas Diff (difg) m2/s	Liquid Mass Trans (Kl) m/s	Gas Mass Trans (Kg) m/s	Total Mass Trans (Kla) m/s
#1	6.23E-10	7.7E-06	2.2E-04	4.9E-03	1.3E-02
#2	ERR	ERR	ERR	ERR	ERR
#3	ERR	ERR	ERR	ERR	ERR

	Tower Height ft	Tower Dia ft
#1	29.09	5.00
#2	ERR	
#3	ERR	

Appendix C
Operation and Maintenance Plan — Carbonair Air Strippers



P.O. Box 5117 · Hopkins, MN 55343-1117
612-935-1844 FAX 612-935-3678

Operation and Maintenance Manual

Carrier Corporation

City of Collierville, Tenn.

Equipment Supplier

Carbonair Services, Inc.

P.O. Box 5117

Hopkins, MN 55343

Phone: 612-935-1844
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Operation and Maintenance Manual

Carrier Corporation

City of Collierville, Tenn.

1.0.0. Purpose and Objectives

The purpose of this O&M manual is to provide City of Collierville, Tenn. operating personnel with detailed information for operation of municipal wellwater treatment equipment located on site at the Carrier Corp. site, Collierville, Tenn.

The objectives of this manual are to provide sufficient information for operators to Start up and continue operation of Carbonair Services Model AS 400 Airstripper, including:

1.1.0. Efficient operation of all treatment units such that effluent water is in compliance with all permit limitations;

1.2.0. Maintenance schedules for all components within the Carbonair equipment.

This manual is organized into system description and operating procedure within the treatment train. All system process, mechanical, electrical, piping, and instrumentation diagrams are provided as appendixes.

2.0.0. System Description

2.1.0. Carbonair Equipment

2.1.1. The Carbonair Model AS-400 airstripper is a 60" diameter air stripper consisting of a steel sump with an Ammerman Model BIB 164 blower, two 60" x 10 foot packing sections containing 3.5" Jaeger Tri-pack packing material, and a 60" demister section. Combined raw water is pumped from 2 well pumps into a 10 steel pipe near the equipment pad and enters into a combined influent header which splits the flow to the two airstrippers. This situation depends on both well pumps running or just one pump running. If only one well pump runs, a motorized



valve mounted in line with the influent header will open and if the other well pump is not operating the motorized on that particular train will be closed to prevent any flow from going into that particular airstripper and vice versa. If both well pumps are operating both influent motorized valves will be open and the flow will split between the two towers. After raw water travels past the motorized valves it enters a FRP Piping header which carries the water to the top of the airstripper. Mounted in this riser pipe is a Signet Flow Meter which will measure the flow for that particular tower. The flow indicator is mounted in the control panel on concrete pad. When water is pumped to the top of the tower it enters a distributor. The water is then dispersed evenly throughout the entire surface area of the media. The water then cascades down over the packing material as air is blown in through the bottom of the tower. When the air and water interface around the packing a stripping action takes place and the contaminants are removed from the water and enter the airstream.

The airflow being fed into the stripper is measured by a magnahelic gauge located in the ducting between the blower and stripper. The airflow from the stripper exits into the ducting in the demister section on the top of the stripper. From there the off gas is then discharged into the atmosphere.

Once the water passes throughout the entire packing sections the water is gathered in the airstripper sumps. Since the discharge of the sumps are piped together into one common header and water levels in the sumps are equal at all times even if only one well pump is operational.

Level controls are mounted on the side of the airstripper sump of one of the units. These level controls will turn on and off the effluent discharge pumps depending if one or both units are operational. Once the discharge pumps are on, there is a flow control valve mounted in line with the discharge piping along with using a pressure transducer mounted near the sump of one of the units and utilizing plastic tubing from a coupling on near the bottom of the sump to the transducer, which will then measure the level of water in the sump in Inches of Water. The transducer then sends that information to the Honeywell Controller in the Control Panel, which in turn



sends a 4-20 ma signal to the motorized valve telling the valve how far it should be open to maintain a certain level of water in the sumps. The level in the sumps will be maintained by the controller, opening and closing the modulating valve according to the incoming flow rates. The treated water, once it passes through the modulating valve, is pumped into the underground pipeline up into the aeration tower for chlorine and other treatment.

3.0.0. Mechanical Equipment List

3.1.0. AS 400 Airstripper

- 3.1.1. Steel skid with steel sump.
- 3.1.2. Blower Model # BIB 164, Type II, Arrangement 9.
- 3.1.3. Blower motor, 5 hp, 460 volts, 3 phase, HZ 60, double belt drive with adjustable motor shieve.
- 3.1.4. Belt size - 4L 500
- 3.1.5. Shaft size - 1 7/16"
- 3.1.6. FRP packing sections: 60" x 124" high with 2-Manways each.
- 3.1.7. FRP demister section: 60" diameter with 16" access manway. Demister section includes a flanged stack if needed at a future date for off gas treatment.
- 3.2.0. Discharge Pumps
- 3.2.1. Model # 3656M close coupled, #12AI21635A
- 3.2.2. Suction Diam. 4"
- 3.2.3. Discharge Diam. 3"
- 3.2.4. Capacity: 500 gpm
- 3.2.5. Total head: 76'
- 3.2.6. Efficiency: 75%
- 3.2.7. Minimum total head at shutoff: (Feet) 105
- 3.2.8. Impeller Diameter in inches: 9
- 3.2.9. RPM: 1750
- 3.2.10. HP: 15
- 3.2.11. Cat. #: JMM 2333T
- 3.2.12. Spec. #: 09P27236
- 3.2.13. Frame 254 JM
- 3.2.14. Serial # 389C
- 3.2.15. TEFC



- 3.2.16. Volts 230/460
- 3.2.17. Amps 38/19
- 3.2.18. Hertz 60
- 3.2.19. Phase 3
- 3.2.20. Class F
- 3.2.21. Wear ring- Cast Iron
- 3.2.22. Impeller- Cast Iron

3.3.0. Blower Specification

- 3.3.1. Model # BIB 164
- 3.3.2. Type II
- 3.3.3. Arrangement 9
- 3.3.4. H.P. 5
- 3.3.5. Volts 460
- 3.3.6. Phase 3
- 3.3.7. Hertz 60
- 3.3.8. Double belt drive with adjustable motor shieve
- 3.3.9. Belt size- 4L 500
- 3.3.10. Shaft size- 1 7/16"

3.4.0. Flow Indicators

- 3.4.1. Quantity 2
- 3.4.2. Model #MK 575 Signet Accum-u-flow
- 3.4.3. Included are accurate fluid flow rate and totalized flow volume readings.

3.5.0. Flow Sensors

- 3.5.1. Type- MK 515 Signet Rotor-X-Flow Sensor
- 3.5.2. Model # MK 515 P1
- 3.5.3. Housing material- Polypro
- 3.5.4. Shaft material- Titanium
- 3.5.5. Pipe Size- 8"
- 3.5.6. Sensor O.D.- 1.05"
- 3.5.7. Sensor Length - 5.00"

3.6.0. Sensor Installation Fittings

- 3.6.1. Model # FPS080
- 3.6.2. Type FRP- Saddle



3.7.0. Pressure Differential Gauges

- 3.7.1. Series 2000
- 3.7.2. Model # 2015
- 3.7.3. Range 0-15"

3.8.0. Pressure Differential Switches

- 3.8.1. Model # 1823-0
- 3.8.2. Operating Range in inches of w.c.- 0.15 to 0.5
- 3.8.3. Approximate Dead Band at minimum set point: 0.06
- 3.8.4. Approximate Dead Band at maximum set point: 0.06

3.9.0. PLC

- 3.9.1. Type: Texas Instruments
- 3.9.2. Inputs: 16 max
- 3.9.3. Outputs: 16 max
- 3.9.4. Note: See specs for more info on PLC

3.10.0. Digital Controller

- 3.10.1. Type: Honeywell Inc.
- 3.10.2. Model # UDC 3000

3.11.0. Pressure Transducer

- 3.11.1. Model # 1151DP4E12
- 3.11.2. Transmitter
- 3.11.3. Power Supply

3.12.0. Flow Control Valves

- 3.12.1. Type: Centerline Valves
- 3.12.2. Series: 6" -A
- 3.12.3. Body: Ductile Iron
- 3.12.4. Disc: Ductile Iron
- 3.12.5. Shaft: Carbon Steel
- 3.12.6. Bushings: Reinforced teflon
- 3.12.7. Seat: Buna N



3.13.0. Electric Actuator

- 3.13.1. Size: 6"
- 3.13.2. Type: Automax Inc.
- 3.13.3. Model: ESP 1000-6
- 3.13.4. Electric Drive Unit and Esp Positioner for 4-20 mA input

3.14.0. Electric Actuator

- 3.14.1. Size: 8"
- 3.14.2. Type: Automax Inc.
- 3.14.3. Model: E-1000
- 3.14.4. Electric Drive unit for on/off service.

3.15.0. Guy Wire

- 3.15.1. 3/8", 5000lb. strength
- 3.15.2. 4 guys per tower
- 3.15.3. 3/4" turnbuckles attached to anchor blocks for tightening purposes.
- 3.15.4. 5000 lb. rated deadend grips used to attach cable to tower guy locations and turnbuckles.

3.16.0. Concrete Anchor Blocks

- 3.16.1. 3' diameter x 3'6" deep
- 3.16.2. 3'4" rebar used including a 3/4" eye for connecting the turnbuckle to the anchor blocks.

3.17.0. Packing Material

- 3.17.1. Jaeger Tri-Packs
- 3.17.2. 3 1/2" Diameter hollow, spherical-shaped.
- 3.17.3. See attached specs and curves for more information.

3.18.0. Upper Distributor

- 3.18.1. Sch. 80 PVC
- 3.18.2. Main header: 8"
- 3.18.3. Slotted laterals: 2 1/2" dia.
- 3.18.4. Laterals have one slot every 13/16



- 3.18.5. Width of slot openings is 1/8"
- 3.18.6. The length of slot is 120 degrees of the pipe circumference.
- 3.18.7. Maximum flow rate is 550 GPM

4.0.0. Process Description

4.1.0. Packed tower airstripping

4.1.1. Contaminated well water is pumped from the two well pumps to the top of the airstripping tower. This water is, in turn, disbursed over the entire bed area of the airstripping tower through a slotted hub lateral inlet distributor assembly. By gravity, the water cascades down into tiny droplets for contact with a counter current airflow in the tower. Depending on the volatility of the contaminant in the water stream, the volatile contaminating components go through a mass transfer from a liquid state to a gaseous state. The gaseous contaminant is now discharged out of the tower through the demister section of the tower and then enters the atmosphere. The treated water is now collected at the bottom of the tower and is pumped out of the Carbonair system and into the elevated storage tower.

4.2.0. Liquid and Air Flow Rates

4.2.1. Design liquid flow rate of each tower is 500 GPM. For optimum performance of the airstrippers this flow rate must not exceed 500 GPM. If exceeded, the air-water ratio will drop below the recommended rate. Design air flow rate of each tower will be 3400 CFM.

With the liquid flow rate of 500 GPM and airflow rate of 3400 CFM, the air-water ratio will be 50-1.

The magnehelic gauge provided in the control panel should be monitored on a weekly basis to assure operator that there is no fouling of the packing during operation. When the magnehelic gauge starts to rise, this means the packing is beginning to foul. Consult Carbonair when operator begins to notice this taking place.



5.0.0. Electrical Description

5.1.0. Existing and Carbonair Electrical Interconnections

5.1.1. The complete Carbonair electrical system was designed with the intention of interconnecting the existing electrical controls on site and identifying the signal to the wells for the call of water. After identifying those wires in the existing panel, those signal wires were then cut and connected to new wires which were then brought to the Carbonair panel through conduit. These wires were then terminated on a terminal strip in the panel. The wiring from the terminal strip to the PLC in the panel was done at the factory. From the signal wires brought in from the existing system, the PLC was then programmed to start and stop, one stripper, both strippers according to those signals. Once the specific piece of equipment starts up, the PLC sends a signal back, utilizing another wire, through the conduit to the existing panel and is joined with the other end of the signal wire that was cut earlier. This will then send the signal for the well pump to start and stop according to what the Carbonair PLC tells it to do.

5.2.0. Basic Control Logic

5.2.1. The system was designed to allow the Carbonair panel to have complete control of the entire system in the automatic mode. The HOA switches for the well pumps in the existing panel room must be in the auto position to allow them to run when using the Carbonair system. The Carbonair system is equipped with HOA switches and wells may be run in the hand position if needed. Once a signal or signals from the level controls in the Ground Storage Tank calling for water is received by the PLC, depending on the signal, one or both of the airstripper blowers will turn on and also one or both of the influent motorized valves will open. There will then be a time delay of 15 seconds before the well pump will start. When the water level in storage tank gets to a certain predetermined height a signal will be sent to the PLC and it will shut down the proper well pump and after a time delay will close the correct influent



motorized valve to assure that no water is allowed into the tower that was just shut off in the event that the other well pump is still running.

5.3.0. Level Controls

5.3.1. Level switches are mounted on the side of one of the airstrippers in a sight glass in a vertical position. There are three switches in the sight glass. The switch on the bottom of the assembly will stop the discharge pump or pumps and the second from the bottom will start the discharge pump or pumps. To explain further, if the system is not operating and there is a call for water from one of the wells, that particular stripper will start up and water will begin to be treated. Once the water level in the sump begins to rise, the water will lift the first switch in the sight glass and nothing will happen, then when the water level reaches the second switch and lifts it then the discharge pump for that stripper will turn on and begin pumping water out of the sump. If a call for water is received for the other well pump to start while the first system is running, stripper # 2 will start up and begin treating water. The discharge pump on this stripper will automatically start after a short delay.

The third level switch in the assembly is the high level switch. If one or both of the discharge pumps fail to operate the water level will reach this switch and once it lifts the switch the well pumps will be shut down along with the blowers for each stripper. The discharge pumps will still operate and when water is pumped down to the bottom level switch they will shut off also. Along with shutdown of the well pumps and blowers a relay will latch making sure that the system will not start back up again without troubleshooting the system to find out what caused the high level situation in the first place. Once the problem has been located and fixed the operator will then have to push a reset button on the panel allow system to restart. Once the relay is latched, it is impossible to run the system in the auto position. If needed, the blower and well pumps may be operated in the manual position.



5.4.0. Pressure Differential Switches

5.4.1. A pressure differential switch is included for each airstripper. In case of blower failure, a set of contacts in the unit will open and send a signal to the PLC that no blower pressure is indicated and again the well pumps and the blowers for each system will shut down automatically. When problem is fixed and ready to restart system, once again the alarm reset button will have to be pushed.

5.5.0. Motorized Valves (On-off)

5.5.1. The two 8" motorized valves open and close according to the specific call for water for each well. If a call for system #1 to start up, the blower for that particular airstripper will start up along with the 8" valve opening. When a call for system #2 to start, again the blower and the 8" valve will open before the well pump starts up. When the storage tank fills up and the call for water ends, the well pump or pumps will turn off and the motorized valves will close also. If one well pump and airstripper turns off and the other continues to operate the motorized valve on that particular train will close and not allow any water to enter that airstripper.

These valves operate on a 110 volt source coming from the Carbonair PLC.

5.6.0. Motorized Actuating Valve

5.6.1. A 6" motorized actuating valve is located on the discharge header. Along with the actuating valve, a pressure transducer is used to indicate the level of water in (inches of water), which sends a signal of that level to the Honeywell controller which in turn sends a 4-20 ma signal to the actuating valve which opens and closes the valve according to the level of water in the sump that is be maintained.

This valve also is operated on a 110 volt source coming form the Carbonair panel.



6.0.0. Preventative Maintenance

6.1.0. Blower

6.1.1. Grease bearings after approximately 4-6 months of operation. One or two pumps of grease is all that is required for these bearings.

6.1.2. Check belts for wear and tightness after 1-2 months of operation and every month after initial check.

6.1.3. Consult Ammerman blower manual for further information on greasing and other maintenance schedules.

6.2.0. Discharge Pumps

6.2.1. Grease once a year. One or two pumps is all that is necessary.

6.3.0. Level Controls and Sight Glass

6.3.1. Periodic cleaning of sight glass may be necessary depending on algae growth. To clean sight glass do the following steps:

1. Turn power off to system including 110 volt power.
2. Remove cover from sight glass junction box.
3. Label wires in junction box before disconnecting.
4. Disconnect wires in junction box and remove sealtite connector and loose wires from junction box.
5. Unscrew 2" brass fitting from assembly and remove level control setup from sight glass.
6. Using a small brush with a long handle insert into sight glass a move in an up and down motion to clean inside of glass. Clean level switch assembly using water and a small soft bristle brush.
7. To reinstall, start at Item #5 and proceed backwards to #1.



6.4.0. Motorized Valves

6.4.1. No maintenance will be necessary. If operator notices any problems he should notify Carbonair as soon as possible.

6.5.0. Signet Flow Meters

6.5.1. If operator notices a drop in flow, it may be necessary to shut system down and remove the flow sensor from the installation fitting and clean the rotor. Once removed, simply clean with fresh water and a small brush or rag to remove any excess grit or grime that may have accumulated on rotor. Reinstall after cleaning, making sure the flow arrow is pointing in the correct position and the tightening nut is tightened properly.

6.5.2. If a sensor, rotor, or O-ring need to be replaced, this can be done in only a matter of seconds. However, Carbonair must be notified immediately as to what is needed how soon it is needed. This will enable us to ship out the parts immediately.

7.0.0. Cleaning of Tower

7.1.0. Acid Wash of Packing Material

7.1.1. A 1 1/2" flange is located on the bottom of each airstripper sump for future use. At that time, this flange may be used to connect a suction line of a recirculating acid wash pump. A blind flange will have to be removed before hooking up the suction hose.

7.1.2. A 1 1/2" FRP coupling is included in the influent header to each tower. A stainless steel flange is provided for hookup for acid wash piping. A steel blind flange will be included which will be removed for hookup with acid wash piping. When acid washing tower, the blind flange shall be removed and install a hose from the discharge side of the acid wash pump to the 1 1/2" FRP coupling.

7.1.3. A 10% solution of Hydrochloric acid is recommended for cleaning the airstripper packing. Consult Carbonair services prior to acid washing the tower. Carbonair will need more information and data to calculate the correct amount of acid to be used.



7.1.4. Before recirculating the acid, operator must close the manually operated butterfly valve located at the base of the FRP influent piping. Doing this will assure that no acid is allowed into the Ductile Iron piping which in contact with acid will deteriorate very quickly.

7.1.5. A blower inlet plate is provided for installing between blower ducting and sump blower flange. Operator will remove blower ducting and attach plate prior to acid washing. This is needed to eliminate any possible damage the vapors or solutions could do to the blower if plate is not used.

8.0.0. Disassembly of Tower

8.1.0. If airstripping towers are ever needed to be disassembled, the following items must be obtained:

8.1.1. A 50 Ton crane with approx. 110' of boom.

8.1.2. Two (2) nylon belts to wrap around tower and choke the belts at 180 degrees from on another below the upper flange of the packing section to be removed.

8.1.3. A 32" extension ladder for hooking up the belts to the crane.

8.1.4. A 9/16" combination wrench and socket w/ratchet.

8.2.0. To take down towers, follow these steps:

8.2.1. Remove signet flow meter from installation fitting. Wrap with some kind of protection device.

8.2.2. Remove bolts from influent header flanges and set on ground.

8.2.3. Wrap nylon belts around tower and hook to crane per instruction # 8.1.2.

8.2.4. Tighten nylon belts gently so there is a bit of a strain on crane.

8.2.5. Loosen guy wires and remove from anchor blocks.

8.2.6. Remove 3/8" nuts from bolts on flange connecting sump to first packing section. Make sure that the crane has a bit of tension on the nylon belts. When all nuts are removed, try to remove bolts from flange before the tower is lifted off



the sump section. This will assure of no damage to the FRP packing section flange. Once bolts are removed, lift off with crane and set on a flat surface.

- 8.2.7. When set on flat surface begin to remove nuts and bolts from flange connecting the tow packing sections together. When unbolted, lift off section using crane and set the top packing section and demister section on another flat surface.
- 8.2.8. Next, you may begin to unbolt the demister section from the upper packing section. When unbolted, lift demister section off.
- 8.2.9. When resting demister section on ground, it should be set on some 6-8" blocks to assure that the upper distributor will not be damaged.
- 8.2.10. Collect all flange gaskets and clean them before reassembly begins.

9.0.0. Reassembly of Tower

9.1.0. Before reassembly begins, make sure that the packing media is filled to their proper heights.

9.2.0. Make sure that the flanges are clean and the gasket material has no foreign material on it.

9.3.0. Again make sure that the flange gaskets are clean.

9.4.0. When ready to reassemble tower, we recommend using a small bead of silicone caulk on the top and bottom of each flange gasket to prevent any leaking of water during operation of the tower.

9.4.1. Install demister section to the upper packing section making sure that sections match at the same location as when tore down. This will assure you of having all flanges and support brackets line up with each other when the reassembly is complete. When all bolts are in place, tighten all bolts slightly, all the way around first, and then snug them up a bit at a time. This will assure proper tension of the flanges all around the entire flange and prevent leaking during operation.



- 9.4.2. When bolts are snug, go around one last time and tighten securely.
- 9.4.3. Set demister and upper packing section onto lower packing section making sure that the manways are lined up correctly. Tighten bolts as previously stated.
- 9.4.4. When tightened, set both packing sections and demister on top of sump section and position correctly. When tight, reattach guy wires and make sure that tower is perfectly plumb. This is very important, because if not plumb, water will tend to move to one side of tower and our efficiency of removal will drop off considerably.
- 9.4.5. When all bolts are tightened and guy wires attached remove crane and nylon belts from tower.
- 9.4.6. Reattach Influent piping and tighten properly.

10.0.0. Removal of Packing Media

10.1.0. If needed, the Jaeger packing material can be removed in two different ways. They are as follows:

- 10.1.1. Unbolting and removing the lower manways of each packing sections. Catching the packing material as it comes out of the manway is very important. This can be done using heavy duty garbage bags or even small drums of some sort. When the media is fouled real bad, it is almost impossible to remove media in this manner.
- 10.1.2. Disassembly of tower and turning the sections upside down and dumping the media into a dumpster. This method has been used quite often but does get fairly expensive if a crane has to be rented.

10.2.0. Consult Carbonair to which procedure would work out the best for your particular need.



11.0.0. Appendices

Appendix A-1-- Site Plot Drawing # CC 437

Appendix A-2-- System Elevation and Plot Drawing # CC 429

Appendix A-3-- Pipe Layout Drawing # CC 473

Appendix A-4-- Pump Control Drawing # CC 518

Appendix A-5-- Process and Instrumentation Drawing # CC
460

Appendix A-6-- Cut sheets for Model 3656-M Pump

Appendix A-7-- Blower Cut sheets

Appendix A-8-- Signet Flow meter cut sheets

Appendix A-9-- Pressure Differential Gauge cut sheets

Appendix A-10-- Pressure Differential Switch cut sheets

Appendix A-11-- PLC cut sheets

Appendix A-12-- Honeywell Digital Controller cut sheets

Appendix A-13-- Pressure Transducer cut sheets

Appendix A-14-- Flow Control Valve cut sheets

Appendix A-15-- Automax Electric Actuator cut sheets

Appendix A-16-- Guy wire Specs

Appendix A-17-- Packing Specifications and Curves

Appendix A-18-- Upper distributor cut sheets

Appendix A-19-- Liquid Level Controls cut sheets



Appendix A-20-- Model AS 400 Sump Section Drawing #
CC- 416 Revision B

Appendix A-21-- Model AS 400 Packing Section Drawing #
CC- 418 Revision B

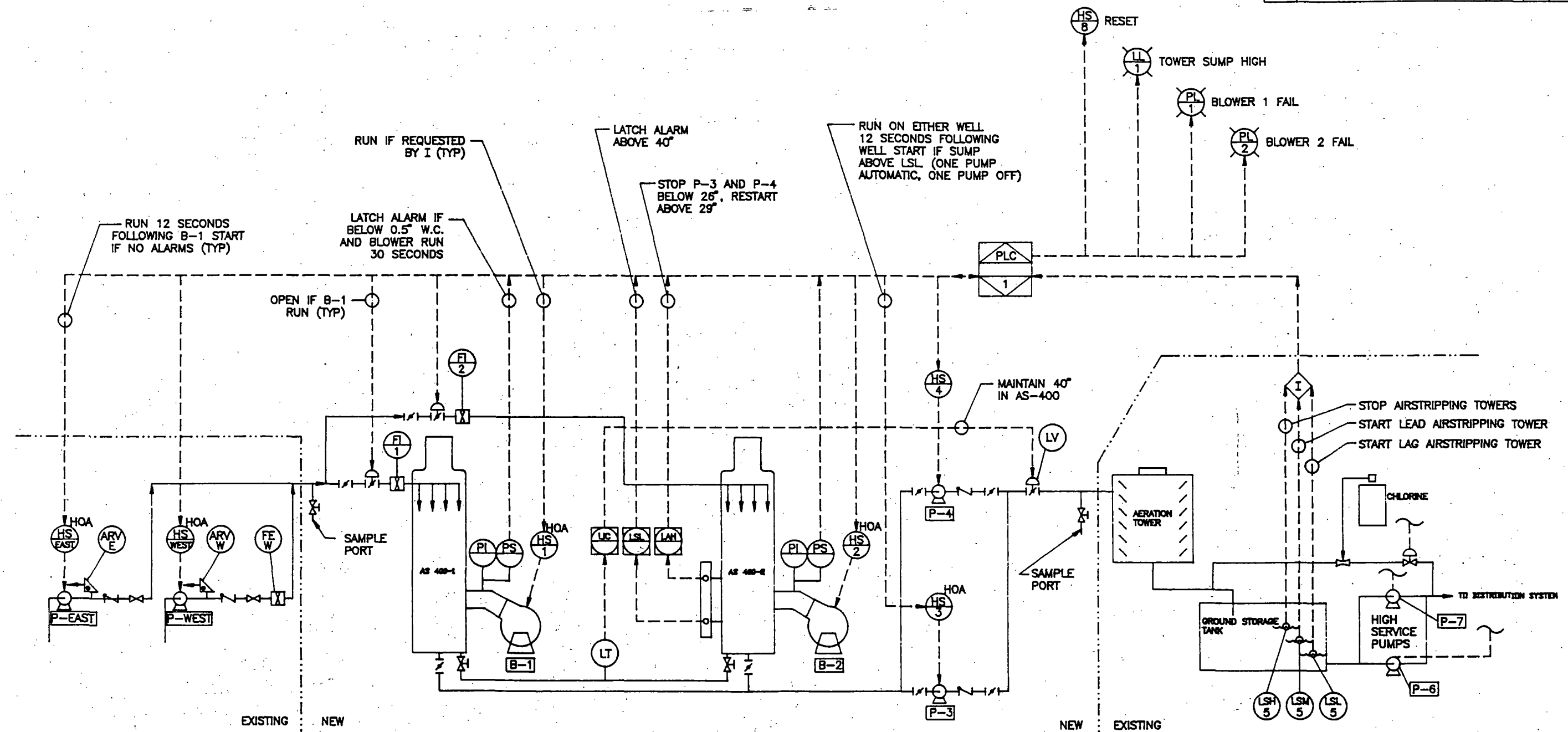
Appendix A-22-- Model AS 400 Demister Section Drawing #
CC- 417 Revision B



PART NUMBER

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
A	SEE ECO	5/18/90	M.P.B.



AUG 22 1990

UNIT PROCESSES

E	EAST WELL
W	WEST WELL
1	AS 400-1
2	AS 400-2
3&4	TOWER EFFLUENT PUMPS
5	AERATION AND GROUND STORAGE
6&7	HIGH SERVICE PUMPS
8	ALARM FUNCTIONS

INSTRUMENT DESIGNATORS

FIRST LETTER	SUCCEEDING LETTERS
H	HAND
L	LEVEL
F	FLOW
A	AIR
P	PRESSURE
S	SWITCH
I	INDICATING
C	CONTROL
T	TRANSMITTER
E	ELEMENT
R	RELEASE
V	VALVE

EQUIPMENT DESIGNATORS

B	BLOWER
P	PUMP

MATERIAL		APPROVAL	DATE	CARBONAIR WATER AND AIR DECONTAMINATION MINNEAPOLIS, MINNESOTA
TOLERANCES UNLESS NOTED OTHERWISE		BY M.P.B.	4/10/90	
DECIMAL .03	FRACTIONAL 1/32"			
THESE MATERIALS ARE CONFIDENTIAL AND ARE THE PROPRIETARY INFORMATION OF CARBONAIR SERVICES, INC. AND MAY NOT BE USED OR REPRODUCED WITHOUT THE CONSENT OF CARBONAIR SERVICES, INC.				
TITLE		P. & I. D.		DWG. NO. CC460 SCALE NONE SHEET 1 OF 1
REV		A		
GROUP NO. AS 400				

Model 3656 M-Group Close-Coupled Unit
Typical Engineering Specifications

I. SCOPE

The contractor shall provide 3 (quantity) horizontal close-coupled, end suction centrifugal pump unit/s, Model 3656 M-Group as manufactured by G & L, A Goulds Pumps Company or equal.

All pump units shall be of one manufacturer and provided complete including electric motor drive.

II. CONDITIONS OF SERVICE

A. Equipment item No.	# <u>3656</u>	<u>12AI21635A</u>	
B. Flange Inside Diameter: Suction (In's) FF	<u>4</u>		
Discharge (In's) FF	<u>3</u>		
C. Primary Service Condition			
Capacity (GPM)	<u>500</u>		
Total Head (Feet)	<u>76</u>		
Efficiency (%)	<u>75</u>		
D. Min. Total Head at Shutoff (Feet)	<u>10.5</u>		
E. Impeller Diameter (In's.)	<u>9</u>		
F. Operating Speed (RPM)	<u>1750</u>		
G. Maximum Motor HP	<u>1.5</u>		

III. PUMP CONSTRUCTION

Each pump shall be designed for clockwise rotation viewed from driven end and include the following design features:

A. Casing

The pump casing shall be spiral volute type, back pull-out design with ASA 150 lb. flat faced flanged suction and discharge connections above 2 1/2" size and shall be constructed of Cast Iron, ASTM A48 CL20 material.

The pump discharge nozzle shall be tangentially oriented.

A pump casing drain shall be provided with a (steel or brass) pipe plug.

B. Wear Ring

Replaceable casing and seal housing wear rings of CI (Cast Iron ASTM A48 CL20 or Bronze ASTM B548) shall be provided and held securely by means of interference fits.

C. Impeller

The pump impeller shall be of enclosed design, constructed of CI (Cast Iron ASTM A48 CL20 or Bronze ASTM B584) material and key driven. A stainless steel cap screw and washer shall provide positive attachment of the impeller to the motor shaft.

D. Seal Housing/Adapter

The seal housing and motor adapter shall be of 1-piece design, constructed of Cast Iron, ASTM A48 CL20. Registered mating fits to the pump casing and C-Flange motor shall maintain positive unit alignment and support. Sealing of casing pressure shall be maintained by an O-Ring of Buna-N material.

Motor and casing connections shall be held securely by means of grade 5, high strength hex head capscrews. A bottom drainage port shall be provided to allow condensation or seal leakage port shall be provided to allow condensation or seal leakage to drain and not be retained within the adapter.

E. Mechanical Seal

The pump shaft seal shall be a John Crane Type 21 mechanical seal or equal constructed of the following materials:

Seal Type	Stationary Face	Rotating Face	Elastomers	Metal Components
Standard	Ceramic	Carbon	Buna-N	18-8 S/S
Option				

F. Shaft Sleeve

The pump shaft sleeve shall be constructed of AISI TYPE 303 stainless steel and shall be of the hook type design, locked in place by the impeller without necessity of other mechanical locking devices.

IV. ELECTRIC MOTOR

The drive motor shall be non-overloading of NEMA standard design with JM shaft extension C-Face mounting suitable for close-coupled pump mounting. Motor rating shall be:

15 HP, 1750 RPM

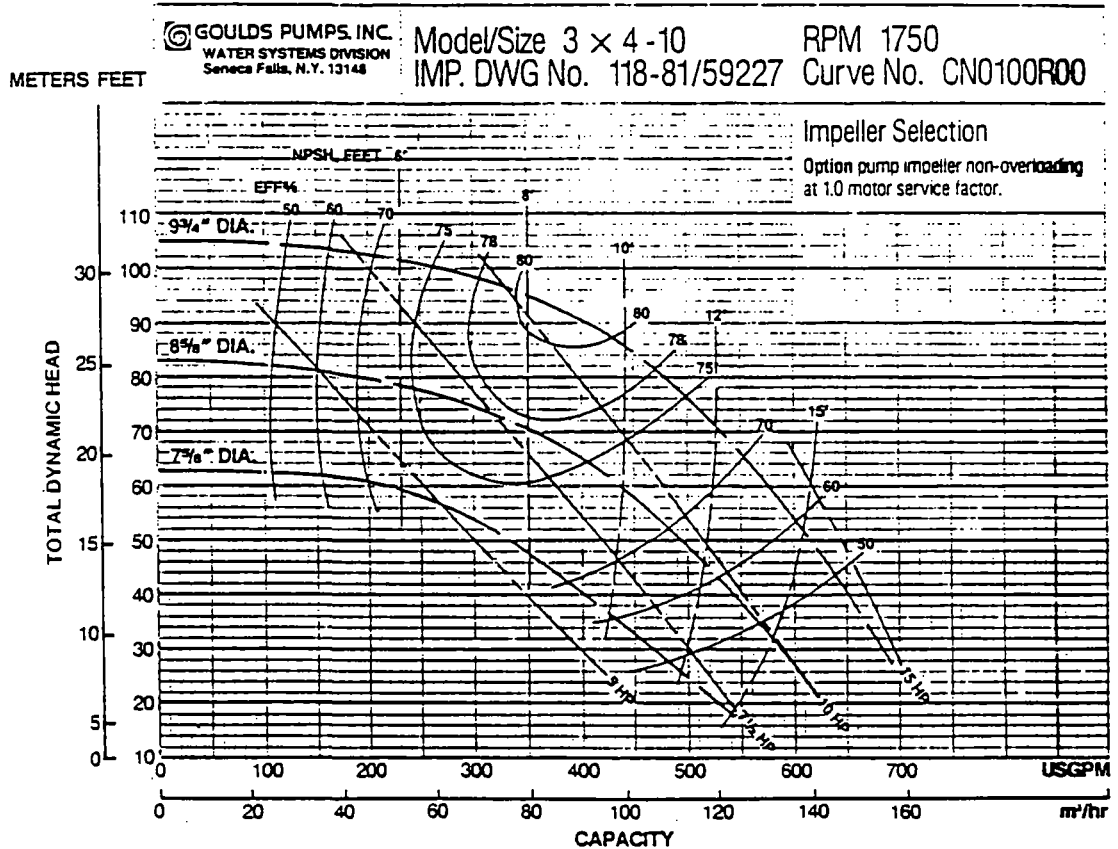
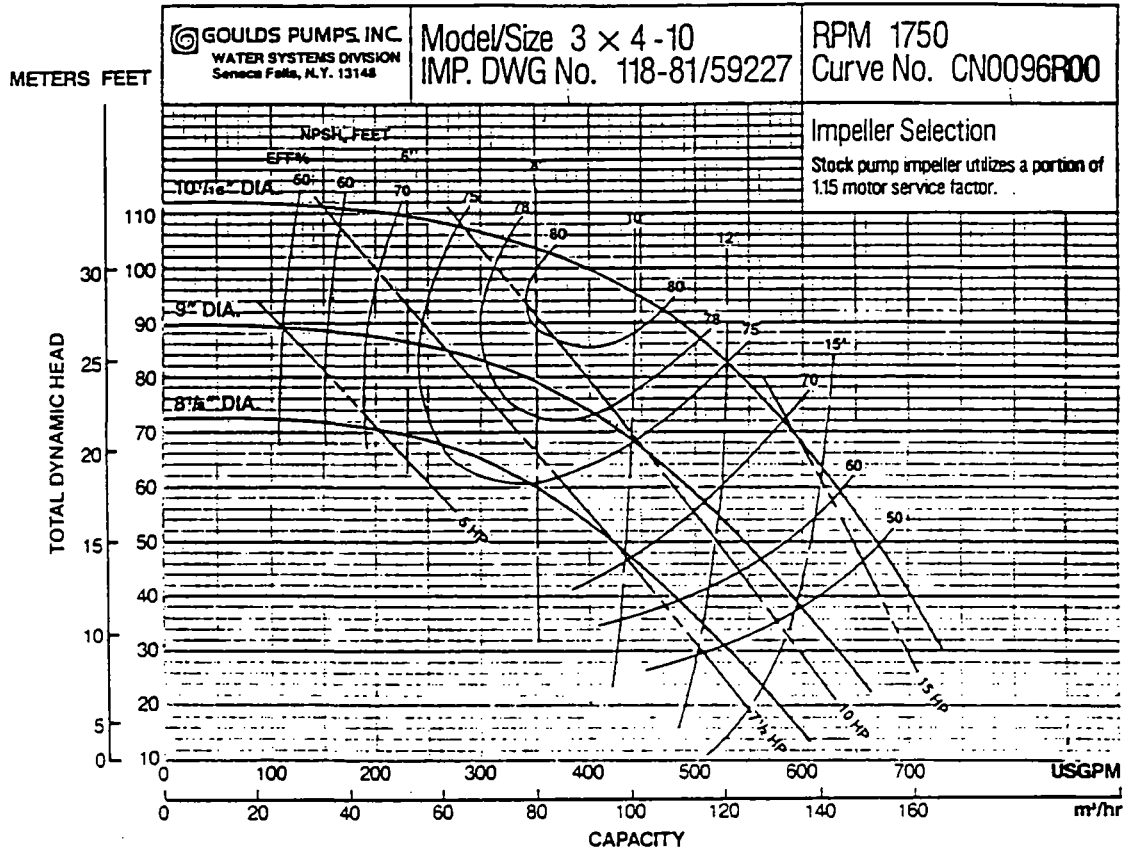
3 phase, 60 Hz, 460 volts

Totally enclosed, fan cooled or open drip-proof

High Efficiency with 1.15 service factor

IV. TESTING

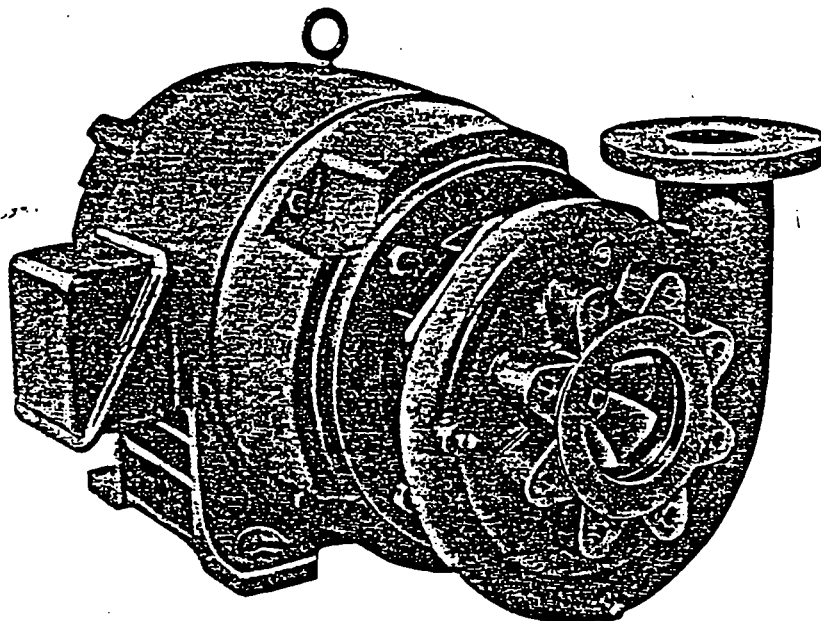
- A. Each pump casing shall be hydrostatically tested by the manufacturer in accordance with Hydraulic Institute Standards at 250 PSIG.
- B. Production performance testing will be conducted by the manufacturer on each pump unit using the actual motor. Head at shut off and a minimum of 2 operating points will be measured at operating speed to verify performance.




Customer _____
Pump Item _____

Condition of Service Imp. Dia. _____
_____ GPM _____ TDH _____ EFF% _____

Certified for: _____ Approval ☐
By _____ Date _____ Record ☐



G&L Close- Coupled Centrifugal Pumps

MODEL 

3656

M-Group

FEATURES

CLOSE COUPLED DESIGN

Compact design saves space and simplifies maintenance.

BACK PULL-OUT

Reduces maintenance down-time.

MECHANICAL SEAL

Standard John Crane Type 21 interchangeable on Model SST-C and Frame mounted Models.

MATERIALS OF CONSTRUCTION

Available in All Iron or Bronze
Fitted for maximum application flexibility.

REPLACEABLE WEARING COMPONENTS

- AISI TYPE 303 Stainless Steel shaft sleeve.
- Iron or Bronze casing and Hub wear ring.

DESIGNED FOR MAXIMUM EFFICIENCY

Enclosed impeller design, dynamic balancing and renewable wear rings reduce losses affecting performance and pump life.

MOTOR ADAPTER

Rigid cast iron motor adapter provides support and registered fits maintain positive unit alignment.

SUCTION & DISCHARGE PIPE CONNECTIONS

Standard 125 lb. ANSI, flat faced flanges.

MOTORS

Standard NEMA Frame, JM shaft extension, C-Face mounting. 3-Phase, 3500 or 1750 RPM. Open Drip-proof and Totally Enclosed Fan Cooled. Interchangeable on Model SST-C.

SPECIFICATIONS

CAPACITIES TO ...

1600 GPM (363 m³/hr) at 3500 RPM
1400 GPM (318 m³/hr) at 1750 RPM

HEADS TO ...

400 ft. TDH (121m) at 3500 RPM
185 ft. TDH (56m) at 1750 RPM

WORKING PRESSURE ...

175 PSIG (12 bars)

MAXIMUM SUCTION PRESSURE TO ...

100 PSIG (7 bars)

MAXIMUM TEMPERATURES TO ...

212°F (100°C) with standard seal
OR

250°F (121°C) with optional high temperature seal for water applications.

DIRECTION OF ROTATION ...

Clockwise when viewed from motor end.

MOTORS ...

NEMA Standard Frame JM shaft extension, C-Face mounting. Open Drip-proof or Totally Enclosed Fan Cooled, High Efficiency 3-Phase, 60 Hz., with 1.15 Service Factor.

208-230/460 volt through 215JM Frames

230/460 volt 250JM and Larger Frames

3500 RPM ... 15 to 75 HP

1750 RPM ... 7½ to 50 HP

Optional Explosion Proof or Premium High Efficiency motors available in 3-Phase only.

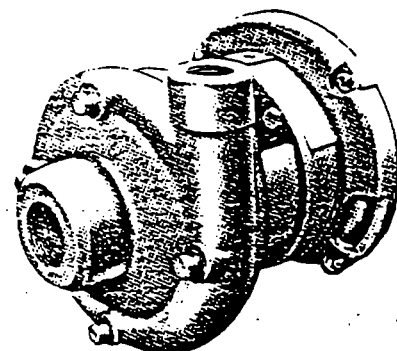
MECHANICAL SEALS ...

Standard ceramic/carbon faces, 316 S/S metal components and Buna-N elastomers. Optional High Temperature and severe duty seal materials available.

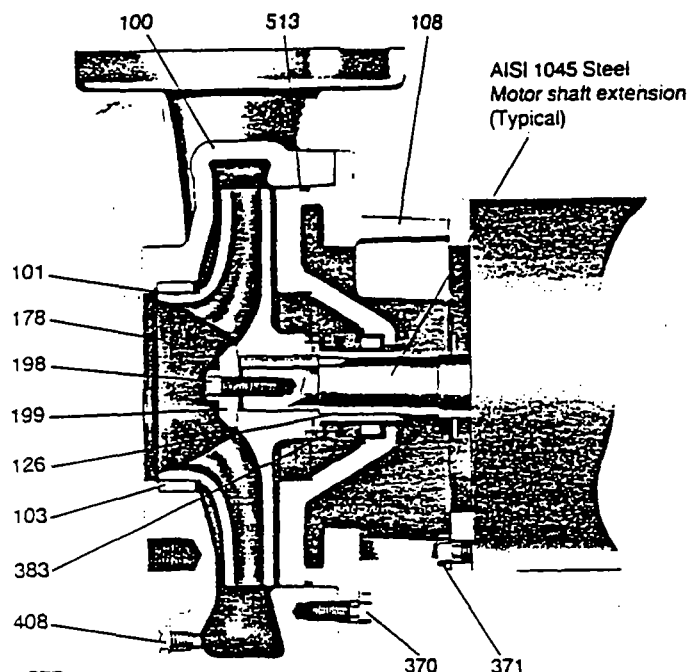
APPLICATIONS

Specifically designed for:

- Water circulation
- Booster service
- Liquid transfer
- Spraying systems
- Irrigation
- General purpose pumping



NPT Threaded Pipe
Connections
1½ x 2-10 and 2½ x 3-8
Models Only.



NOTE:

Seal Housing Wear Ring (item #203) not shown above. See repair parts page for detail. (Required for all Models except 3 x 4-10)

MATERIALS OF CONSTRUCTION

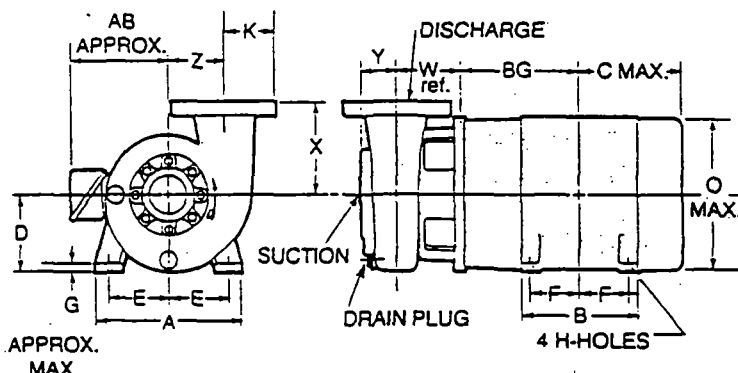
Item No.	Part Name	Material			
		All Iron	Bronze Fitted		
100	Casing	1001	1001		
101	Impeller		1102		
103	Casing Wear Ring		1102		
108	Adapter/Seal Housing		1001		
126	Shaft Sleeve	AISI TYPE 300 Series Stainless Steel			
178	Impeller Key				
198	Impeller Bolt				
199	Impeller Washer				
370	Hex Head Cap Screw Adapter to Case	SAE 1200 Series Steel Grade 5			
371	Hex Head Cap Screw Adaoter to Motor				
383	Mechanical Seal	Goolds Part No.	Service Rotary Stationary Elastomers Metal Parts		
	STD.	10K16	General	Ceramic Buna	Type 316 S.S.
	OPT.	10K20	Hi-Temp Carbon	Ni-Resist EPR	
	OPT.	10K26	Chem. Duty	Ceramic Viton	
408	Pipe Plug 1/4" or 3/8"	Steel Brass			
513	O-Ring	Buna-N			
Materials of Construction	Material Code		Engineering Standard		
	1001		Cast Iron ASTM A48 CL20		
	1102		Bronze ASTM B584		

All pumps shipped in vertical discharge position. May be rotated in 90° increments. Tighten casing bolts to 90 ft.-lbs. torque.

PUMP DIMENSIONS AND WEIGHTS

Pump	125# ANSI Flg. Suct. Disch.	W (ref.)	X	Y	Z	K	Wt. (lbs.)
1½ x 2-10	2 1½	5	6	3	5½	1¼	90
2½ x 3-8					5	1½	75
2½ x 3-10	3 2½		7½	2¼	5½		82
2½ x 3-13			9	3	7½	3½	136
3 x 4-7		5½	6	2½	5		90
3 x 4-10	4 3		7½		5½	3¾	96
3 x 4-13		5	9		7½		152
4 x 5-8	5 4	5½	8		5	4½	96
4 x 6-13	6	5¼	9		7½		168

Note: 1½ x 2-10 and 2½ x 3-8 NPT Threaded Connections



MOTOR FRAMES/HORSEPOWER

Frame Size JM	ODP	TEFC	RPM
213 TCZ	7½	7½	1750
215 TCZ	10	10	
254	15	15	
256	20	20	
284	25	25	
286	30	30	
324	40	40	
326	50	50	3500
215 TCZ	15	—	
254	20	15	
256	25	20	
284	30	25	
286	40	30	
324	50	40	
326	60	50	
364 TCZ	75	60	
365 TCZ	—	75	

Note: 213/215 frames have 250JM shaft extension.
364/365 frames have 324JM shaft extension.

MOTOR DIMENSIONS AND WEIGHTS (may vary with manufacturer)

Frame Size JM	A	AB	B	BG	(max.) C	D	E	F	G	H	(max.) O	Weight of Motor (lbs.)
213 TCZ	10½	9½	7	7¼	8	5¼	4¼	2¾	¾	13/32	11¼	110 122
215 TCZ			8½	8	8¾			3½				120 124
254	12¾	10½	10½	9½	10	6¼	5	4½	¾	17/32	13¾	169 265
256			12¼	10	10¾			5				217 315
284	13¾	12¾	12¼	9¾	11¾	7	5½	4¾	¾	17/32	15	314 408
286			13¾	10½	11¾			5½				375 422
324	15¾	15½	13¾	10¾	12¾	8	6¼	5¼	1¾	21/32	17	446 562
326			14	11½	13¾			6				542 588
364 TCZ	17¾	17¾	14¾	12¾	15	9	7	5¾	1	21/32	19¼	690 775
365 TCZ			15½	13¼	15½			6½				1005 805

(All dimensions in inches and weights in lbs. Do not use for construction purposes.)

Blower Specification

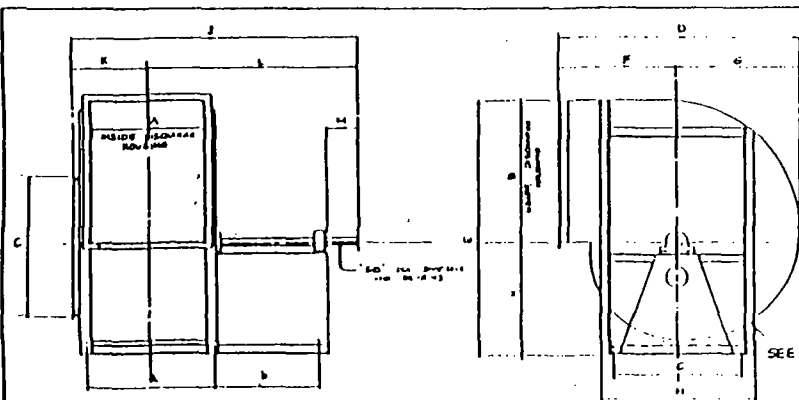
Model BIB-164 Type II, Arrangement 9
5 HP, 460 volt, 3 phase, 60 Hz motor with
double belt drive and adjustable motor
shieve.



BIB CENTRIFUGAL FAN

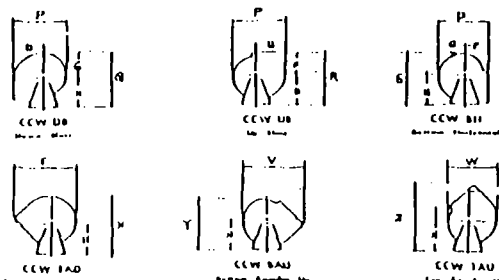
GENERAL DIMENSION:

ARRANGEMENT 1 & 9



TOP HORIZONTAL DISCHARGE, COUNTERCLOCKWISE

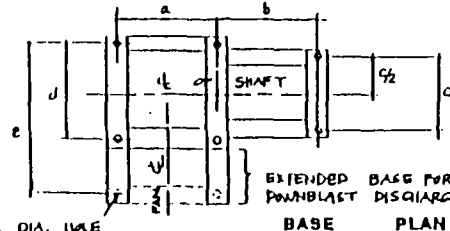
FAN DISCHARGES: VIEWED FROM DRIVE SIDE



COUNTERCLOCKWISE ABOVE, CLOCKWISE OPPOSITE
ANGULAR DISCHARGES ARE SET UP ON 45°

NOTE 8:

1. FAN SUPPORTS FOR SIZES 122 TO 270 SHALL BE FORMED PLATES AT 90° BREAKS. SIZES 300 TO 890 SHALL BE STEEL ANGLE.
2. FOR ARRANGEMENT 9, MOTOR MAY BE LOCATED TO THE LEFT OR RIGHT SIDE OF BEARING PEDESTAL.



FAN SIZE	A	B	C	D	E	F	G	H			J	K	L	M	N	30" CLASS I		36" CLASS I		P	Q	R	S	T	V	W	X	Y	Z	BASE DIMENSION						INLET COLLAR	OUTLET FLANGE	MAX MOTOR FRAME	FAN SIZE
								100 120	140	160						30" 36"	KEYWAY	30" 36"	KEYWAY																				
																														a	b	c	d	e	f				
122	8 1/2	13	13 1/2	20 1/2	30	10 1/2	10 1/2	17	17	17	34 1/2	7 1/2	27 1/2	2 1/2	16	1	1 1/2	1 1/2	22 1/2	27 1/2	27 1/2	26 1/2	31 1/2	26 1/2	19 1/2	28 1/2	26	33 1/2	12 1/2	18	12	13 1/2	--	1/2	1 1/2	184	T	122	
134	10 1/2	14 1/2	14 1/2	22 1/2	31 1/2	11 1/2	11 1/2	17	17	17	36 1/2	7 1/2	27 1/2	2 1/2	17	1	1 1/2	1 1/2	24 1/2	28 1/2	28 1/2	27 1/2	34 1/2	29	21 1/2	29 1/2	26 1/2	35 1/2	12 1/2	18	12	14 1/2	--	1/2	1 1/2	184	T	134	
160	11 1/2	15 1/2	16 1/2	25 1/2	33 1/2	12 1/2	12 1/2	18	18	18	38 1/2	8 1/2	30	3 1/2	19	1	1 1/2	1 1/2	27 1/2	31	30 1/2	29 1/2	37 1/2	32 1/2	24 1/2	31 1/2	28 1/2	38	14 1/2	19 1/2	12	16	--	1/2	1 1/2	184	T	150	
164	13	17 1/2	17 1/2	28	35 1/2	13 1/2	14 1/2	18	18	20	43 1/2	8 1/2	34	3 1/2	21	1 1/2	1 1/2	29 1/2	33 1/2	33 1/2	32	40 1/2	35 1/2	26 1/2	34 1/2	31 1/2	41 1/2	14 1/2	23 1/2	16	17 1/2	--	1/2	1 1/2	215	T	164		
182	14 1/2	19 1/2	19 1/2	30 1/2	38 1/2	14 1/2	15 1/2	19	21	22	45 1/2	11 1/2	34 1/2	3 1/2	23	1 1/2	1 1/2	33 1/2	37	36	35 1/2	44 1/2	38 1/2	29 1/2	38 1/2	34 1/2	45 1/2	16 1/2	23 1/2	16	19 1/2	--	1/2	1 1/2	215	T	182		
200	15 1/2	21 1/2	21 1/2	32 1/2	41 1/2	15 1/2	17 1/2	20	22	24	47 1/2	12 1/2	34 1/2	3 1/2	25	1 1/2	1 1/2	36 1/2	37 1/2	39 1/2	38 1/2	47 1/2	42 1/2	32 1/2	39 1/2	34 1/2	46	18 1/2	23 1/2	16	21 1/2	--	1/2	1 1/2	215	T	200		
220	17 1/2	23 1/2	23 1/2	36 1/2	45 1/2	17 1/2	19 1/2	22	22	26	51 1/2	13 1/2	37 1/2	4	27	1 1/2	1 1/2	40 1/2	37 1/2	41 1/2	42 1/2	52 1/2	47	36	40 1/2	41 1/2	49 1/2	20 1/2	25 1/2	18	22 1/2	--	1/2	1 1/2	256	T	220		
244	19 1/2	25 1/2	26 1/2	40 1/2	49 1/2	19 1/2	21 1/2	24	24	28	55 1/2	14 1/2	41	4 1/2	30	1 1/2	1 1/2	44 1/2	41 1/2	48	46 1/2	57 1/2	52	30 1/2	44 1/2	45 1/2	54 1/2	22 1/2	26 1/2	18	22 1/2	--	1/2	1 1/2	256	T	244		
270	21 1/2	28 1/2	28 1/2	44 1/2	52 1/2	21	23 1/2	24	24	31	57 1/2	15 1/2	42 1/2	4 1/2	33	1 1/2	1 1/2	49	45 1/2	50 1/2	51 1/2	62 1/2	57	43 1/2	49 1/2	50	60 1/2	24 1/2	26 1/2	18	26 1/2	--	1/2	1 1/2	256	T	270		
300	23 1/2	31 1/2	31 1/2	50	56 1/2	24	26	25	27	35	64 1/2	16 1/2	47 1/2	5	40	1 1/2	1 1/2	54 1/2	49 1/2	55 1/2	57 1/2	69 1/2	63	48 1/2	53 1/2	50 1/2	65 1/2	26 1/2	28 1/2	25	33 1/2	--	1/2	1 1/2	284	T	300		
330	26	34 1/2	34 1/2	55	61 1/2	26 1/2	28 1/2	27	30	38	66 1/2	17 1/2	48	5	44	1 1/2	1 1/2	59 1/2	54 1/2	62	63	75 1/2	70	53 1/2	58 1/2	55 1/2	71 1/2	28 1/2	28 1/2	25	37 1/2	65	1/2	1 1/2	284	T	330		
364	28 1/2	38 1/2	38 1/2	60 1/2	68 1/2	29	31 1/2	30	33	41	70 1/2	20 1/2	50 1/2	5	47	1 1/2	1 1/2	66 1/2	60 1/2	68 1/2	68 1/2	83 1/2	77	59 1/2	63	61 1/2	79 1/2	31 1/2	30 1/2	25	40 1/2	60	1/2	10	2 1/2	286	T	364	
400	31 1/2	42 1/2	42 1/2	66 1/2	75 1/2	31 1/2	34 1/2	33	36	45	75 1/2	21 1/2	54	5	51	1 1/2	1 1/2	73 1/2	66 1/2	76 1/2	76	92 1/2	85	65 1/2	69	68	87 1/2	34 1/2	33 1/2	30	44 1/2	66	1/2	10	2 1/2	286	T	400	
440	35	46 1/2	46 1/2	72 1/2	83 1/2	33 1/2	38 1/2	36	40	50	79 1/2	23 1/2	56	5 1/2	57	2 1/2	2 1/2	80 1/2	72 1/2	85 1/2	83 1/2	100 1/2	93	72 1/2	76 1/2	74 1/2	95 1/2	39	33 1/2	30	47 1/2	72	1 1/2	10	2 1/2	326	T	440	
490	38 1/2	51 1/2	51 1/2	79 1/2	91	37 1/2	42 1/2	39	44	55	87 1/2	24 1/2	63 1/2	5 1/2	62	2 1/2	2 1/2	88 1/2	79 1/2	90	92 1/2	110 1/2	103	79 1/2	82 1/2	81 1/2	105 1/2	42 1/2	36 1/2	32	51 1/2	79	1 1/2	10	2 1/2	326	T	490	
540	42 1/2	57 1/2	57 1/2	87 1/2	101 1/2	40 1/2	46 1/2	43	49	60	91 1/2	26 1/2	65 1/2	6	68	2 1/2	2 1/2	98 1/2	87 1/2	97	101 1/2	121	113	88 1/2	91 1/2	90 1/2	115 1/2	46 1/2	36 1/2	32	57 1/2	88	1 1/2	10	2 1/2	365	T	540	
600	46 1/2	60 1/2	63 1/2	96 1/2	113	44 1/2	51 1/2	48	54	66	97 1/2	27 1/2	70	6	74	2 1/2	2 1/2	108 1/2	96 1/2	108 1/2	112	133	125	97 1/2	100	99 1/2	127 1/2	51 1/2	36 1/2	40	62	96	1 1/2	10	2 1/2	365	T	600	
660	51 1/2	69 1/2	69 1/2	105 1/2	124 1/2	49	56 1/2	53	59	73	104 1/2	32 1/2	72 1/2	7	80	2 1/2	2 1/2	119 1/2	105 1/2	118 1/2	123 1/2	146	137	107	110	109 1/2	139 1/2	57 1/2	39 1/2	44	66	105	1 1/2	10	2 1/2	365	T	660	
730	57 1/2	77 1/2	76 1/2	120 1/2	134 1/2	57 1/2	62 1/2	57	64	80	113 1/2	35 1/2	77 1/2	7 1/2	88	2 1/2	2 1/2	132 1/2	120 1/2	122 1/2	136 1/2	161	154	118 1/2	121	121	157	63	41 1/2	64	74	116	1 1/2	7	2 1/2	405	T	730	
800	63 1/2	85 1/2	84 1/2	133 1/2	148 1/2	63 1/2	69 1/2	63	72	89	123 1/2	38 1/2	84 1/2	8	98	2 1/2	2 1/2	146 1/2	133 1/2	135 1/2	150 1/2	177	170	130 1/2	133	133	173	69	44	80	82	128	1 1/2	7	2 1/2	405	T	800	
890	70 1/2	94 1/2	93 1/2	147 1/2	163 1/2	70 1/2	76 1/2	70	78	97	132 1/2	42	90 1/2	8	106	3 1/2	3 1/2	161 1/2	147 1/2	148 1/2	165 1/2	196	186	144 1/2	147	148	190	74	47	80	84	140	1 1/2	7	2 1/2	405	T	890	

TOLERANCES ± 1/8"

DIMENSIONS NOT TO BE USED FOR CONSTRUCTION UNLESS CERTIFIED

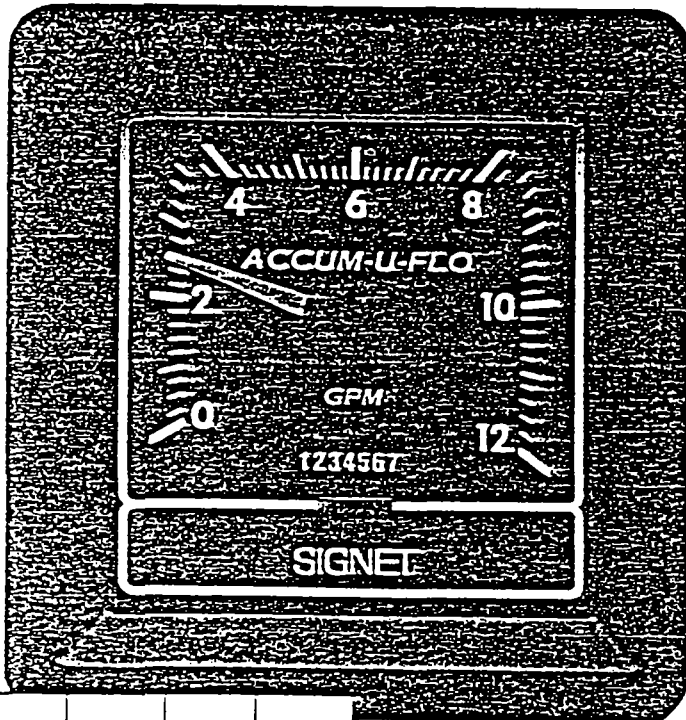
*FOR ARR. 1 & 9 ONLY

WHEEL DIAMETER	INLET AREA	DISCHARGE AREA	TIP SPEED	MAXIMUM BHP
16 1/2"	1.718 SQ. FT.	1.57 SQ. FT.	F.P.M. = 4.32 x RPM	0.35 $\left(\frac{\text{RPM}}{1000}\right)^3$

CFM	OV	1/4" SP		3/8" SP		1/2" SP		5/8" SP		3/4" SP		7/8" SP		1" SP		1-1/4" SP		1-1/2" SP		2" SP		2-1/2" SP	
		RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
1200	764	824	0.08	696	0.11	783	0.14	824	0.17	883	0.20	940	0.25	994	0.29	1098	0.38	1118	0.41	1210	0.52		
1400	892	680	0.11	746	0.14	808	0.17	865	0.20	920	0.25	972	0.29	1022	0.32	1118	0.41	1210	0.52				
1600	1019	740	0.14	801	0.17	858	0.20	911	0.25	962	0.29	1011	0.32	1059	0.38	1149	0.48	1234	0.58	1396	0.79	1546	1.04
1800	1146	803	0.17	858	0.22	911	0.26	962	0.30	1010	0.34	1058	0.39	1101	0.43	1186	0.53	1268	0.64	1419	0.86	1561	1.11
2000	1274	868	0.22	919	0.27	968	0.30	1015	0.35	1061	0.40	1105	0.44	1147	0.50	1228	0.60	1304	0.70	1449	0.93	1584	1.20
2200	1401	935	0.28	982	0.32	1028	0.38	1072	0.43	1115	0.48	1158	0.53	1197	0.58	1274	0.68	1347	0.80	1485	1.04	1614	1.29
2400	1529	1004	0.34	1047	0.40	1089	0.44	1131	0.50	1171	0.56	1211	0.60	1249	0.65	1323	0.78	1393	0.88	1525	1.13	1649	1.41
2600	1656	1073	0.43	1114	0.48	1153	0.54	1192	0.59	1233	0.64	1267	0.69	1304	0.78	1374	0.88	1442	1.00	1569	1.28	1688	1.54
2800	1783	1144	0.51	1182	0.56	1219	0.63	1255	0.68	1291	0.75	1326	0.81	1361	0.88	1428	1.00	1493	1.12	1615	1.38	1730	1.67
3000	1911	1214	0.60	1250	0.66	1285	0.73	1320	0.80	1353	0.86	1387	0.93	1420	0.98	1484	1.12	1546	1.26	1664	1.54	1775	1.83
3200	2038	1286	0.71	1320	0.79	1353	0.86	1385	0.93	1418	0.98	1449	1.06	1480	1.12	1542	1.27	1601	1.41	1715	1.70	1823	2.00
3400	2166	1358	0.85	1390	0.91	1422	0.98	1452	1.06	1483	1.13	1513	1.20	1543	1.28	1601	1.43	1658	1.58	1768	1.87	1872	2.20
3600	2293	1430	0.98	1461	1.06	1491	1.13	1520	1.21	1549	1.29	1578	1.37	1606	1.45	1662	1.60	1717	1.75	1822	2.08	1923	2.41
3800	2420	1503	1.14	1532	1.22	1561	1.31	1589	1.38	1617	1.46	1644	1.54	1671	1.62	1724	1.79	1777	1.98	1878	2.29	1978	2.52
4000	2548	1576	1.31	1604	1.39	1631	1.48	1658	1.56	1685	1.66	1711	1.73	1737	1.82	1788	1.98	1838	2.18	1936	2.50	2031	2.97
4200	2675	1649	1.51	1676	1.60	1702	1.68	1728	1.77	1753	1.86	1779	1.95	1803	2.04	1852	2.22	1901	2.40	1995	2.75	2086	3.12
4400	2803	1722	1.70	1748	1.81	1774	1.89	1798	1.98	1823	2.08	1847	2.17	1871	2.27	1918	2.45	1964	2.63	2055	3.02	2144	3.40
4600	2937	1795	1.90	1819	2.00	1843	2.09	1866	2.18	1889	2.28	1911	2.37	1933	2.47	1980	2.65	2024	2.83	2113	3.16	2200	3.60
4800	3067	1869	2.10	1891	2.20	1914	2.29	1936	2.38	1957	2.48	1978	2.57	1998	2.67	2044	2.85	2087	3.03	2175	3.39	2260	3.90
5000	3197	1943	2.30	1964	2.40	1986	2.49	2007	2.58	2027	2.68	2047	2.77	2067	2.87	2112	3.05	2154	3.23	2241	3.65	2324	4.20
5200	3327	2017	2.50	2037	2.60	2058	2.69	2078	2.78	2097	2.88	2116	2.97	2135	3.07	2179	3.25	2219	3.43	2305	3.85	2386	4.50
5400	3457	2091	2.70	2110	2.80	2130	2.89	2149	2.98	2168	3.07	2186	3.16	2204	3.26	2247	3.44	2286	3.62	2371	4.07	2450	4.80

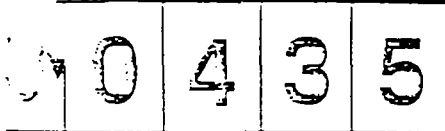
CFM	OV	3" SP		3-1/2" SP		4" SP		4-1/2" SP		5" SP		5-1/2" SP		6" SP		6-1/2" SP		7" SP		7-1/2" SP		8" SP	
		RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
2000	1274	1713	1.47	1826	1.77																		
2200	1401	1737	1.58	1855	1.88	1968	2.20	2078	2.54														
2400	1529	1766	1.70	1879	2.00	1988	2.23	2093	2.57	2196	3.04	2295	3.40										
2600	1656	1801	1.83	1909	2.15	2014	2.47	2115	2.83	2214	3.20	2310	3.56	2403	3.97	2494	4.37						
2800	1783	1839	1.98	1944	2.31	2044	2.65	2142	3.00	2237	3.37	2330	3.75	2420	4.18	2508	4.57	2595	4.99	2680	5.42		
3000	1911	1881	2.15	1982	2.47	2079	2.83	2173	3.18	2266	3.55	2354	3.95	2442	4.35	2528	4.77	2612	5.20	2694	5.65	2775	6.10
3200	2038	1925	2.33	2023	2.66	2117	3.02	2208	3.39	2297	3.77	2384	4.16	2466	4.58	2551	5.00	2633	5.44	2713	5.89	2791	6.35
3400	2166	1971	2.52	2066	2.87	2158	3.24	2247	3.60	2333	4.00	2417	4.41	2499	4.82	2579	5.25	2658	5.69	2736	6.15	2812	6.61
3600	2293	2020	2.75	2112	3.09	2201	3.47	2288	3.85	2371	4.25	2453	4.68	2533	5.08	2611	5.51	2688	5.97	2763	6.44	2837	6.91
3800	2420	2070	2.97	2160	3.34	2247	3.72	2331	4.12	2412	4.51	2492	4.94	2570	5.37	2646	5.82	2720	6.26	2794	6.74	2866	7.21
4000	2548	2122	3.24	2209	3.60	2294	4.00	2378	4.40	2458	4.82	2533	5.24	2609	5.67	2683	6.12	2756	6.58	2827	7.06	2898	7.55
4200	2675	2175	3.50	2260	3.90	2343	4.30	2423	4.70	2501	5.12	2577	5.55	2651	6.00	2721	6.45	2794	6.94	2864	7.41	2932	7.91
4400	2803	2229	3.79	2313	4.19	2393	4.60	2471	5.02	2547	5.47	2622	5.93	2694	6.35	2765	6.83	2834	7.30	2902	7.80	2969	8.30
4600	2937	2282	4.04	2362	4.47	2438	4.90	2513	5.35	2586	5.82	2658	6.29	2728	6.78	2796	7.28	2862	7.79	2927	8.31	2991	8.84
4800	3067	2340	4.31	2417	4.77	2490	5.20	2563	5.67	2634	6.15	2704	6.64	2772	7.14	2838	7.67	2902	8.20	2965	8.74	3027	9.29
5000	3197	2400	4.59	2475	5.07	2545	5.50	2616	6.00	2685	6.50	2753	7.01	2819	7.54	2883	8.08	2945	8.63	3006	9.18	3066	9.74
5200	3327	2460	4.87	2535	5.35	2602	5.80	2670	6.30	2737	6.81	2803	7.33	2867	7.87	2929	8.42	3000	8.97	3060	9.53	3118	10.08
5400	3457	2522	5.15	2595	5.63	2660	6.10	2726	6.60	2791	7.12	2855	7.65	2918	8.19	2979	8.74	3048	9.29	3106	9.84	3163	10.38
5600	3587	2582	5.43	2655	5.91	2718	6.38	2782	6.88	2845	7.40	2907	7.93	2968	8.47	3027	9.02	3085	9.57	3142	10.12	3198	10.68
5800	3717	2642	5.71	2715	6.19	2776	6.66	2838	7.16	2898	7.69	2957	8.22	3015	8.76	3072	9.31	3128	9.86	3183	10.41	3237	11.18
6000	3847	2702	6.00	2775	6.48	2834	6.94	2893	7.44	2950	7.95	3006	8.48	3061	9.02	3115	9.57	3168	10.12	3220	10.67	3271	11.71
6200	3977	2762	6.28	2834	6.76	2891	7.20	2948	7.70	3003	8.22	3057	8.75	3110	9.29	3162	9.84	3213	10.39	3263	10.94	3312	12.23
6400	4107	2822	6.56	2893	7.04	2948	7.44	3003	7.94	3056	8.46	3108	8.99	3159	9.53	3209	10.08	3258	10.63	3306	11.18	3353	12.73
6600	4237	2882	6.84	2953	7.32	3007	7.72	3060	8.22	3112	8.75	3163	9.28	3213	9.82	3262	10.37	3310	10.92	3357	11.48	3403	13.23
6800	4367	2942	7.12	3013	7.60	3066	8.00	3118	8.50	3169	9.03	3219	9.56	3268	10.10	3316	10.65	3363	11.20	3409	11.76	3454	13.73
7000	4497	3002	7.40	3073	7.88	3126	8.28	3177	8.78	3227	9.31	3276	9.84	3324	10.38	3371	10.93	3417	11.48	3463	12.31	3508	14.23
7200	4627	3062	7.68	3133	8.16	3186	8.56	3236	9.06	3285	9.59	3333	10.12	3380	10.67	3426	11.23	3472	11.78	3517	12.36	3561	14.73

Accurate, Low-Maintenance Flow Volume Indicators



MK 575/MK 575R ACCUM-U-FLO

Just a quick glance at Signet's MK 575 Accum-u-flo gives you accurate fluid flow rate and totalized flow volume readings. By having both these essential flow functions combined on one convenient unit, you'll save space and eliminate additional expense. Flow rate is displayed on an easy-to-read 5½ inch analog dial. While totalized volume is presented on a low-maintenance, electro-mechanical counter. Choose from a 7-digit non-resettable counter (MK 575) for continuous totalizing or a 5-digit front resettable counter (MK 575R) for periodic totalizing. The MK 575's 245 degree, high-torque meter gives you *greater resolution in high-vibration areas*. With a resulting flow rate accuracy of $\pm 1\%$ of full scale—and totalized volume accuracy of $\pm 2\%$ of calibrated flow rate. And, you can easily interface the Accum-u-flo with other TTL compatible equipment. Includes a 117 VAC to 12 VDC power converter.



SPECIFICATIONS:

Display Accuracy (MK 575): $\pm 1\%$ of full scale

Display Repeatability
(MK 575): $\pm 0.5\%$ of full scale

Volume Display Accuracy: $\pm 2\%$ of full scale

Pulse Output:

TTL Compatible: Source, 6.5 mA at 4.6 V
Sink, 25 mA at 0.4 V

Counter:

TTL Compatible: Source, 5 mA
Sink, 5 mA

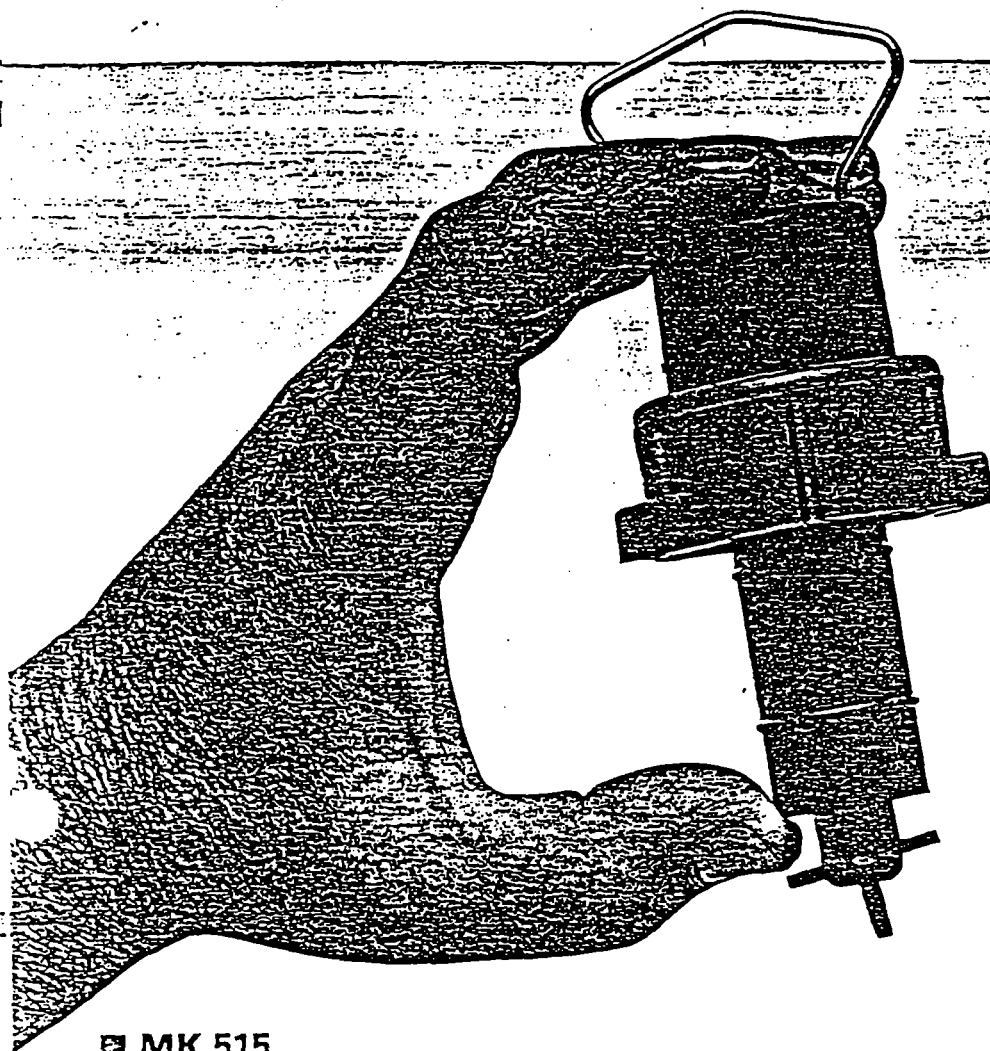
Power Requirements:

Nominal 8 to 18 VDC, at 315 mA Not damaged by voltage spikes as high as 25 VDC. (Power converter included) Includes reverse voltage protection.

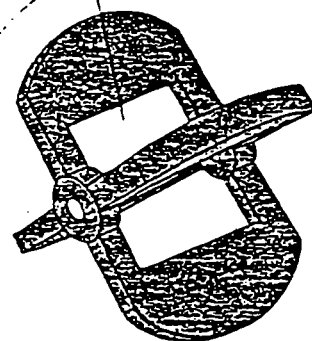
Dimensions:

5½ inch square bezel
(requires 5.1 inch panel cutout) 4.75 inches deep

The Flow Sensor That Makes Short Work Of Your Flow Measurement



Patented, "flow-through" rotor design ensures accurate, linear output to $\pm 1\%$.



MK 515 ROTOR-X™ FLOW SENSOR

Streamline your flow measurement operation with the MK 515 ROTOR-X™ Flow Sensor. By using this compact flow sensor, a matched sensor installation fitting, a Signet flow meter or controller, and ordinary hand tools, you'll have a complete flow monitoring or controlling system—in minutes. Accurate to $\pm 1\%$ of full scale, with repeatability at $\pm 0.5\%$ of full scale, this insertion sensor operates on a simple electromechanical principle. And, it's proven in thousands of liquid flow applications worldwide. It all adds up to precision, dependability, and convenience—basic advantages that are quickly outdating its in-line counterparts.

A TIMESAVER YOU CAN BANK ON

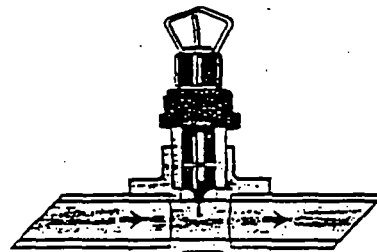
Convert your maintenance hours into minutes, with the ROTOR-X™. Should a sensor, rotor, or O-ring need to be replaced, it takes only seconds. Reduce your system downtime substantially with a stand-alone MK 515 sensor. Or, simply add an MK 319 Wet Tap Assembly and completely eliminate downtime. Combined with the ROTOR-X™ during initial installation, the MK 319 Wet Tap allows sensor removal without system shut-down.

Optional local or remote capability lets you place your meter up to 200 feet away without signal amplification. And, you can install the MK 515 in pipe sizes ranging from 1/2 inch to

36 inches without a lot of additional cost, because the ROTOR-X price increases only slightly for larger pipe sizes.

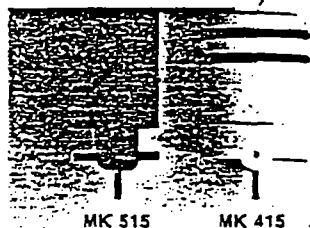
RUGGED CONSTRUCTION FOR LONG WEAR

Available in a choice of chemically resistant, non-contaminating housing materials, the ROTOR-X stands up to the harshest environments. The glass-filled polypropylene housing version is lightweight—but strong. A feature which makes it ideal for handling a wide range of liquids, including corrosive fluids in chemical processing. For processes containing acids and solvents, the PVDF (polyvinylidene fluoride) housing version is a tough fluorocarbon that is highly resistant to more severe fluids, such as acids and solvents. (See PVDF section for more information on Signet's all PVDF flow monitoring systems.)



FLOW MEASUREMENT SIMPLE AND ACCURATE.

The ROTOR-X works on a simple, but precise, electro-mechanical principle based on measuring the rate and volume of flow in your pipe. Four permanent magnets, imbedded in the rotor blades, spin past a coil in the sensor body. As the fluid flow causes the rotor to rotate, a sine wave signal is produced, directly proportional to the flow rate. The patented "open cell" feature of the rotor ensures a linear, repeatable output, up to 50 fps —with accuracy of



MK 515 MK 415

±1% of full scale. The result—minimal head loss and no cavitation. Additionally, you can combine the ROTOR-X Flow Sensor with an intrinsic safety barrier (contact the factory for a list of suggested

barriers) for use in hazardous environments.

MK 415

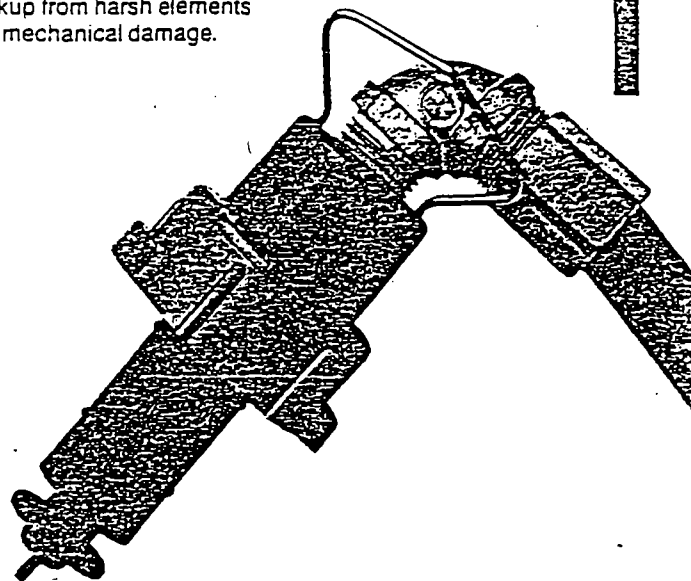
The MK 415 offers all the performance features of the MK 515, plus greater clearance between the rotor and the housing. Designed for fluids with up to 10% particulate matter, this unit is ideal for ground and sea water monitoring, and measuring agricultural irrigation water.

QUICK, EASY CONDUIT INSTALLATION

Designed to allow optional conduit installation, the MK 515 lets you easily comply with local codes requiring conduit protection. For instance, pry off the plug on top of the sensor. Underneath it you'll find a ½ inch (F) NPT thread. Now, using an optional conduit adaptor fitting kit, connect your conduit. And, either an optional instrument back-cover kit, or a specially prepared NEMA box, will provide everything you need for quick conduit connection to a meter or controller. Additionally, you can adapt to both rigid and flexible liquid-tight conduit, protecting your system hookup from harsh elements and mechanical damage.

SPECIFICATIONS:

Output Signal:	MK 515 1V p-p/fps	MK 415 0.44V p-o/fps nominal
Output Frequency:	5-6 Hz/fps nominal	
Flow Rate Range:	1-50 fps	1.5 fps-50 fps
Linearity:	±1% of full range	
Output Accuracy:	±1% of full range	
Repeatability:	±0.5% of full range	
Maximum % Solids:	1% of fluid volume	10% of fluid volume
Standard Cable Length:	25 feet	



HOW TO ORDER

ROTOR-X™ FLOW SENSORS

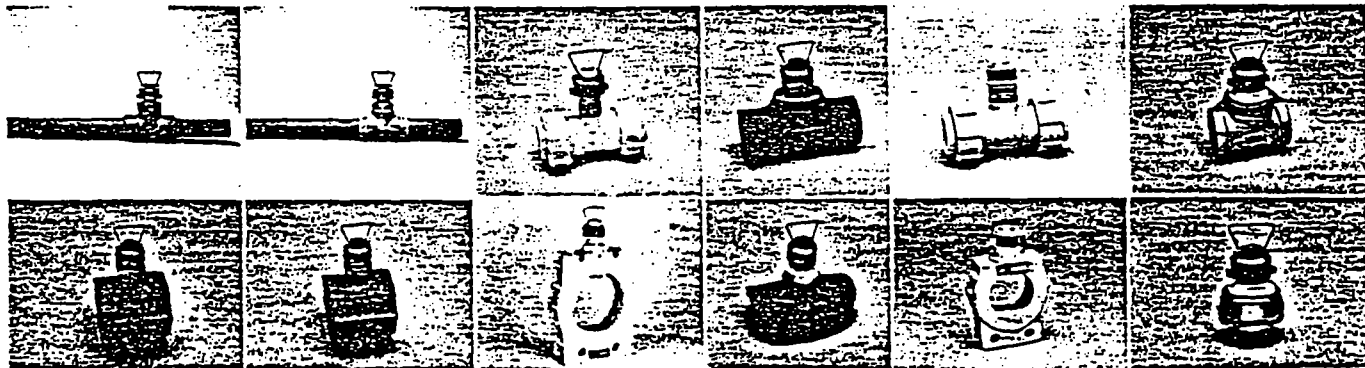
Part No.	Housing Material	Shaft Material	Pipe Size (in.)	Sensor O.D. (in.)	Sensor Length (in.)
MK 515-P0	Polypro	Titanium	½-4	1.05	3.50
MK 515-P1	Polypro	Titanium	5-8	1.05	5.00
MK 515-P2	Polypro	Titanium	10-UP	1.05	7.75
MK 515-V0	PVDF	Hastelloy C	½-4	1.05	3.50
MK 515-V1	PVDF	Hastelloy C	5-8	1.05	5.00
MK 515-V2	PVDF	Hastelloy C	10-UP	1.05	7.75

Sensor Installation Fittings

MK 515/565

PIPE MATL	PVC 40 & 80	CPVC 80	PVDF	FIBERGLASS	POLYPROPYLENE	STAINLESS 316
--------------	-------------	---------	------	------------	---------------	---------------

FPS080



Part Number:

PV8T020

Pipe/Tubing Size

Type

Schedule

Material or Type

Fitting Styles:

T = "TEE" PVC, CPVC and fiberglass have slip ends. PVDF (metric) has socket ends; copper (for copper and brass tubing) has "sweat-on" ends; iron, brass, carbon steel, and stainless steel have threaded ends.

S = Saddle "Cement-on" for PVC & CPVC; "double strap-on" for iron; "cement-on" for fiberglass. Please specify wall thickness and O.D. for fiberglass; and pipe schedule for PVC or iron.

W = Weldolet Weld to existing pipe: please specify pipe schedule.

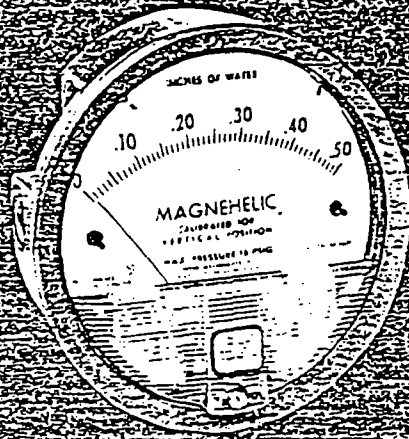
B = Brazolet Braze to existing pipe: please specify pipe schedule.

Dwyer

SERIES
2000

Magnehelic® Differential Pressure Gages

Indicate low air or gas pressures—positive, negative or differential. Accurate within 2% of Ranges.



Standard Magnehelic Pressure Gage has a large easy-to-read dial.

Dimensions: Standard Series 2000 Magnehelic Pressure Gage (Slightly different for non-standard ranges and pressure units)

Select the Dwyer Magnehelic® gage for high accuracy — guaranteed within 2% of full scale — and for the wide choice of 31 ranges available to suit your needs precisely. Using Dwyer's simple, frictionless Magnehelic® movement, it quickly indicates low air or non-corrosive gas pressures — either positive, negative (vacuum) or differential. The design resists shock, vibration and over-pressures. No manometer fluid to evaporate, freeze or cause toxic or leveling problems. It's inexpensive, too.

Widely used to measure fan and blower pressures, filter resistance, air velocity, furnace draft, pressure drop across orifice plates, liquid levels with bubbler systems and pressures in fluid amplifier or fluidic systems. It also checks gas-air ratio controls and automatic valves, and monitors blood and respiratory pressures in medical care equipment.

Mounting. A single case size is used for most ranges of Magnehelic gages. They can be flush or surface mounted with standard hardware supplied. With the optional A-510 Pipe Mounting Kit they may be conveniently installed on horizontal or vertical 1/4"-2" pipe. Although calibrated for vertical position, many ranges above 1 inch may be used at any angle by simply re-zeroing. However, for maximum accuracy, they must be calibrated in the same position in which they are used. These characteristics make Magnehelic gages ideal for both stationary and portable applications. A 4 1/2" hole is required for flush panel mounting. Complete mounting and connection fittings plus instructions are furnished with each instrument.



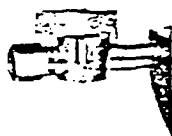
Flush... Surface... or Pipe Mounted

Vent valves

In applications where pressure is continuous and the Magnehelic gage is connected by metal or plastic tubing which cannot be easily removed, we suggest using Dwyer A-310A vent valves to connect gage. Pressure can then be removed to check or re-zero the gage.

HIGH AND MEDIUM PRESSURE MODELS

Installation is similar to standard gages except that a 4 1/4" hole is needed for flush mounting. The medium pressure construction is rated for internal pressures up to 35 psig and the high pressure up to 80 psig. Available in all ranges. Because of larger case, will not fit in portable case. Weight 1 lb., 10 oz. (Installation of the A-321 safety relief valve on standard Magnehelic gages often provides adequate protection against infrequent overpressure; see Bulletin S-101).



PHYSICAL DATA

Ambient temperature range: 20° to 140°F.*

Rated total pressure: -20" Hg. to 15 psig.*

Connections: 1/4" NPT high and low pressure taps, duplicated — one pair side and one pair on back.

Housing: Die cast aluminum. Case and aluminum parts Iridite-dipped to withstand 168 hour salt spray test. Exterior finish is baked dark gray hammerloid.

Standard ranges: See facing page.

Accuracy: Plus or minus 2% of full scale (3% on -0 and 4% on -00 ranges), throughout range at 70°F.

Standard accessories: Two 1/4" NPT plugs for duplicate pressure taps, two 1/4" pipe thread to rubber tubing adapters, and three flush mounting adapters with screws. (Mounting ring and snap ring retainer substituted for 3 adapters in MP & HP gage accessories.)

Weight: 1 lb., 2 oz.

*Low temperature models available as special option.
*For applications with high cycle rate within gage total pressure rating, next higher rating is recommended. See Medium and high pressure options at lower left.

OPTIONS AND ACCESSORIES

Transparent overlays

Furnished in red and green to highlight and emphasize critical pressures.

Adjustable signal flag

Integral with plastic gage cover; has external reset screw. Available for all ranges (not high pressure). Can be ordered with gage or separately.

Portable units

Combine carrying case with any Magnehelic gage of standard range (not high pressure). Includes 9 ft. of 1/4" I.D. rubber tubing, stand-hang bracket, and terminal tube with holder.

Air filter gage accessory package

Adapts any standard Magnehelic for use as an air filter gage. Includes aluminum surface-mounting bracket with screws, two 5 ft. lengths of 1/4" aluminum tubing, two static pressure taps and two molded plastic vent valves, integral compression fittings on both taps and valves.



Quality design and construction features

Bezel provides flange for flush mounting in panel.

Clear plastic face is highly resistant to breakage. Provides undistorted viewing of pointer and scale.

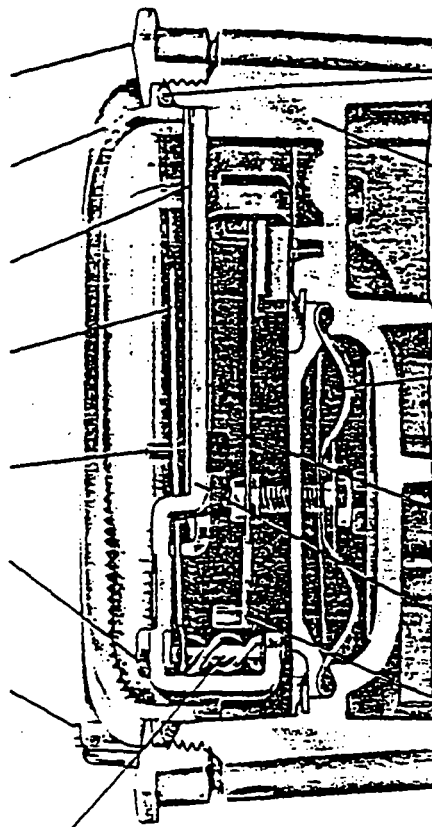
Precision litho-printed scale is accurate and easy to read.

Red tipped pointer of heat treated aluminum tubing is easy to see. It is rigidly mounted on helix shaft.

Pointer stops of molded rubber prevent pointer over-travel without damage.

Sapphire bearings are shock-resistant mounted; provide virtually friction-free motion for helix. Motion damped with high viscosity silicone fluid.

Zero adjustment screw is conveniently located in plastic cover, accessible without removing cover. "O" ring seal provides pressure tightness.



—“O” ring seal for cover assures pressure integrity of case.

Die cast aluminum case is precision made. Iridite-dipped to withstand 168 hour salt spray test. Exterior finished in baked dark gray hammerloid. One case size used for all standard pressure ranges, and for both surface and flush mounting.

Silicone rubber diaphragm with integrally molded "O" ring is supported by front and rear plates. It is locked and sealed in position with a sealing plate and retaining ring. Diaphragm motion is restricted to prevent damage due to overpressures.

Calibrated range spring is a flat leaf of Swedish spring steel in temperature compensated design. Small amplitude of motion assures consistency and long life. It reacts to pressure on diaphragm. Live length adjustable for calibration.

"Wishbone" assembly provides mounting for helix, helix bearings and pointer shaft.

Samarium cobalt magnet mounted at end of range spring rotates helix without mechanical linkages.

Helix is precision milled from an alloy of high magnetic permeability, deburred and annealed in a hydrogen atmosphere for best magnetic qualities.

Mounted in jeweled bearings, it turns freely to align with magnetic field of magnet to transmit pressure indication to pointer.

SERIES 2000 MAGNEHELIC® – MODELS AND RANGES

The models below will fulfill most requirements. Page 5 also shows examples of special models built for OEM customers. For special scales furnished in ounces per square inch, inches of mercury, metric units, etc., contact the factory.

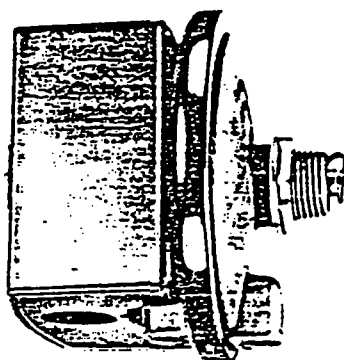
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SERIES
1800

Low Differential Pressure Switches for General Industrial Service

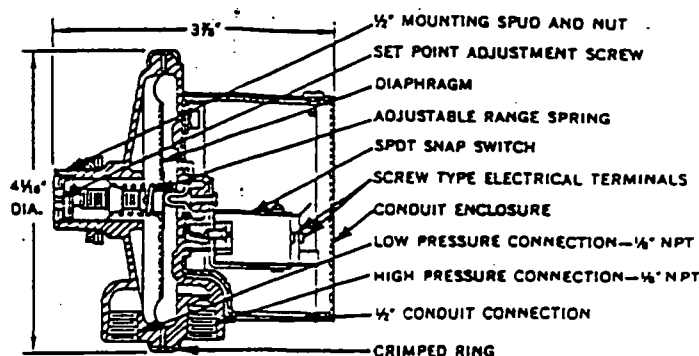
Compact, economically priced switches in 8 standard ranges. Set points from 0.15" to 85" W.C. Repetitive accuracy within 2%. U.L. and C.S.A. listed, F.M. approved.



Model 1823 pressure switch. U.L. and C.S.A. listed, F.M. approved.



Series 1823 pressure switch. Conduit enclosure removed to show electric switch.



Construction and dimensions. Series 1823 pressure switches.

One of our most popular pressure switches. Combines small size and low price with 2% repeatability for enough accuracy for all but the most demanding applications. Set point adjustment inside the mounting spud permits mounting switch on one side of a wall or panel with adjustment easily accessible on the opposite side.

U.L. and C.S.A. listed, F.M. approved.

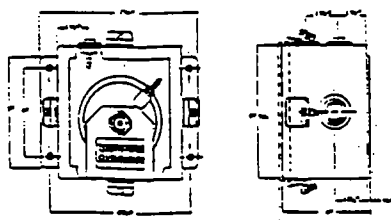
*Model 1823 shown; (1823 replaces 1820, 1821 and 1822 which are similar).

Environmental (MIL) Switch

Unlisted Model 1820 can be furnished with special snap switch sealed against the environment for temperatures down to -65°F ., high humidity and/or for government applications. Similar to standard Model 1823 except dead band is slightly greater. Specify Model 1820 (Range No.) "MIL" in ordering.

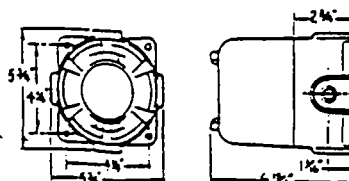
Weatherproof Enclosure

16 ga. steel enclosure for unusually wet or oily conditions. Withstands 200 hour salt spray test. Gasketed cover. Weight 5½ lbs. Switch must be installed at factory. Specify "WP" in addition to switch catalog number.



Explosion-Proof Housing

Cast iron base and aluminum dome cover. Approximate weight 7½ lbs. Specify "EXPL" in addition to switch catalog number.



PHYSICAL DATA

Temperature limits: -30°F for dry air or gas to 180°F .

Maximum surge pressure: 25 psig

Rated pressure: 10 psig.

Pressure connections: ¼" NPT.

Electrical rating: 15 amps, 120-480 volts, 60 Hz. A.C. Resistive ¼ H.P. @ 125 volts, ¼ H.P. @ 250 volts. 60 Hz A.C. See INSTALLATION for derating information above 130°F .

Wiring connections: 3 screw type, common, normally open and normally closed.

Set point adjustment: Screw type inside mounting spud.

Housing: Aluminum die casting. Steel fittings zinc plated, dichromate dipped for 200 hour salt spray test.

Diaphragm: Silicone rubber on dacton with aluminum support plate.

Calibration Spring: Stainless steel.

Mounting spud: ½" pipe thread.

Weight: 1 lb., 5 oz.

Installation: Diaphragm vertical.

SERIES 1823 SWITCHES: OPERATING RANGES AND DEAD BANDS. U.L. and C.S.A. Listed, F.M. Approved.

Model Number	Operating Range Inches, W.C.	Approximate Dead Band	
		At Min. Set Point	At Max. Set Point
1823-0	0.15 to 0.5	0.06	0.06
1823-1	0.3 to 1.0	0.08	0.08
1823-2	0.5 to 2.0	0.10	0.12
1823-5	1.5 to 5.0	0.14	0.28
1823-10	2.0 to 10	0.18	0.45
1823-20	3 to 22	0.35	0.70
1823-40	5 to 44	0.56	1.1
1823-80	9 to 85	1.3	3.0

Suggested Specification

Differential pressure switches shall be diaphragm operated with 4" diaphragm to actuate a single pole double throw snap switch. Motion of the diaphragm shall be restrained by a calibrated spring that can be adjusted to set the exact pressure differential at which the electrical switch will be actuated. Motion of the diaphragm shall be transmitted to the switch button by means of a direct mechanical linkage. Switches shall be Dwyer Instruments, Inc. Catalog No. 1823-_____ for the required operating ranges.

How to Order: See price list, Bulletin S-26.

SERIES 1823 DIFFERENTIAL PRESSURE SWITCHES

Specifications — Installation & Operating Instructions — Parts List



INSTALLATION AND OPERATION

INSTALLATION

1. Select a location free from excessive vibration where oil or water will not drip upon the switch and where ambient temperature will not exceed 130°F. See special housings for unusual conditions.
2. Mount the switch with the diaphragm in a vertical plane. Must be recalibrated for each change in operating position.
3. Connect switch to source of pressure differential. Metal tubing with 1/4" O.D. is recommended but any tubing system which will not restrict the air flow unduly is satisfactory. Note that the low pressure connection may be made to the 1/2" stud at the back of the switch if desired. If so connected, drill 1/16" diameter holes in the Spring Retainer flange (PN 1823-309) and the head of Adjustment Screw (PN 1823-289) to provide opening to the switch interior and plug the other low pressure connection.
4. Electrical connections to the standard single pole, double throw snap switch are provided by means of screw terminals marked "common", "norm open", and "norm closed". The normally open contacts close and the normally closed contacts open when pressure increases beyond the set point.
5. Switch loads should not exceed the maximum specified current rating of 15 amps resistive. Switch capabilities decrease with an increase in ambient temperature above 130°F, high load inductance, or rapid cycle rates. Whenever an application involves one or more of these factors,

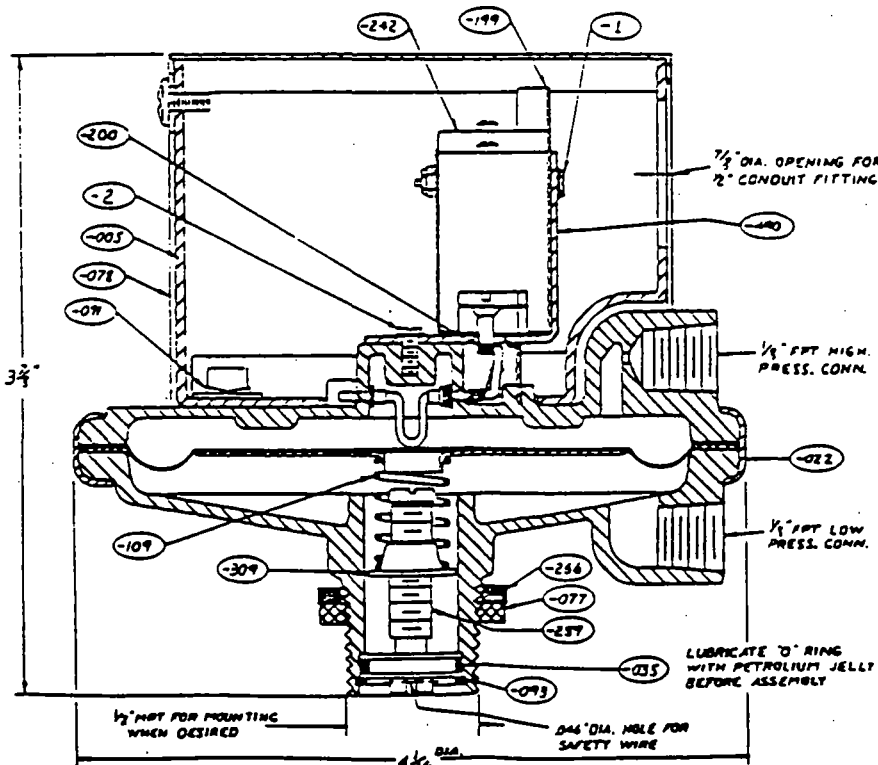
the user may find it desirable to limit the switched current to 10 amps or less in the interest of prolonging switch life.

ADJUSTMENT

1. If the switch has been factory preset, check the set-point before placing in service to assure it has not shifted in transit.
2. If switch has not been preset or if it is desired to change the set point, observe the following procedure:
 - a. To adjust the set point turn the slotted Adjustment Screw (PN 1823-289) clockwise to increase the set point and counter-clockwise to decrease the set point.
 - b. Important Note. The following is a recommended procedure for calibrating or checking calibration: Use a "T" assembly with three rubber tubing leads, all as short as possible and the entire assembly offering minimum flow restriction. Run one lead to the pressure switch, another to a manometer of known accuracy and appropriate range, and apply pressure through the third tube. Make final approach to the set point slowly. Note that manometer and pressure switch will have different response characteristics due to different internal volumes, lengths of tubing, oil drainage, etc. Be certain switch is checked in position it will assume in use, i.e., vertical, horizontal, etc.

CROSS SECTIONAL VIEW

Part No.	Name
1823-005	Conduit Enclosure (1)
1823-022	Switch Body Assembly — Aluminum Die Casting Diaphragm Assembly .008" Silicone on Nylon and Aluminum Assembly Ring (1)
1823-035	"O" Ring 1/2" X 5/8" (1)
1823-077	Mounting Nut — 1/2" Electrical Nut — Steel (1)
1823-078	Conduit Cover Assembly (1)
1823-091	Conduit Enclosure Fasteners — Tinnerman Speed Nut (4)
1823-093	Retaining Ring (1)
1823-109	Calibration Spring — Stainless Steel (1)
1823-199	Insulation Shield — 1/32" Thick Hard Fibre (1)
1823-200	Switch Button — Nylon (1)
1823-242	Micro-Switch #BZ-RW84-A2
1823-266	Mounting Washer — 1-5/32" O.D. X .844" I.D. — Steel (2)
1823-289	Calibration Adjustment Screw (1)
1823-309	Calibration Spring Retainer — Brass (1)
1823-490	Switch Bracket — Steel (1)
1823-1H	#6-32 X 1 Steel Screw #6L Brass Washer #6-32 Lock Nut
1823-2H	#6-32 X .5/16" Steel Screw



When corresponding with the factory regarding 1800 series switch problems, please refer to the call-out numbers in this view to assure proper identification. Be sure to include the operating range and any optional features. Field service is not recommended. Contact the factory for service information.

Litho in U.S.A. 11/83
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F. R. No. 24-440258-00

Dwyer Instruments, Inc.

P. O. BOX 373, MICHIGAN CITY, INDIANA 46360, U.S.A.

Phone: AC 219-872-9141

TI325 and TI330 Hardware Overview

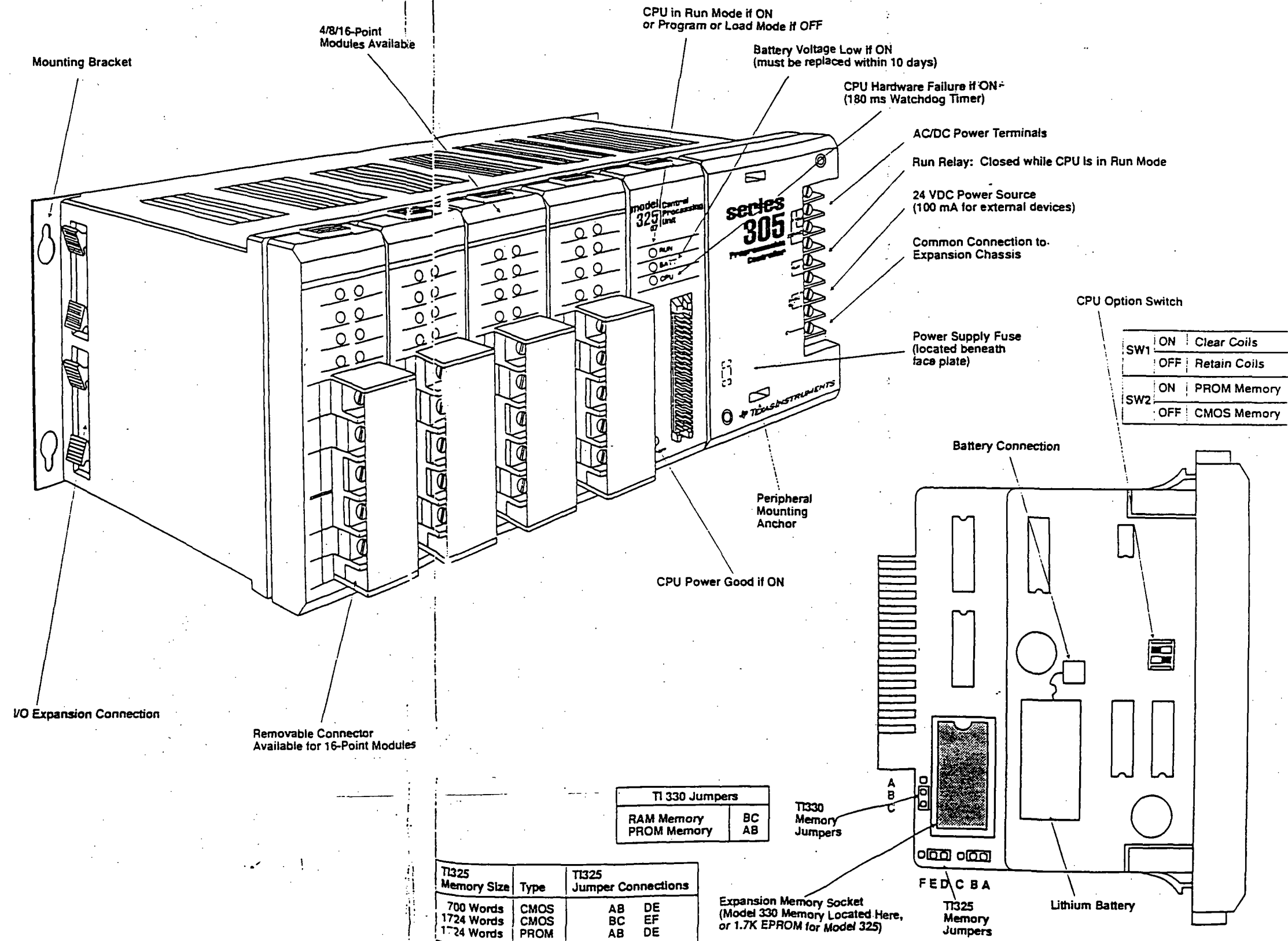
Even though small and inexpensive, the TI325 and TI330 models offer true modular design, a broad range of I/O options, and versatility that is otherwise found only in much larger units.

The I/O range extends up to 168 points, while memory can be expanded from 700 words to 3,700. With peer-to-peer communications, the user can transfer I/O status or data between as many as four Series 305 systems. I/O options include more than 30 types of discrete, analog, high-speed counter, and other types of specialty modules (see I/O selection guide, page 22, for a complete listing of modules).

TI325 and TI330 Specifications

	TI325	TI330
I/O points	168	168
Total memory		
Standard, CMOS RAM	0.7K	3.7K
Expansion, CMOS RAM	1.7K	n/a
Optional, EPROM	1.7K	3.7K
Scan times [typical]		
0.5K program	8 ms	8 ms
1.0K program	12 ms	12 ms
1.7K program	15 ms	15 ms
3.7K program	n/a	36 ms
Internal functions		
Total number of instructions	53	53
Integer math	Y	Y
Password protection	Y	Y
Total number of internal coils	140	140
Nonretentive coils	112	112
Retentive coils	28	28
Special function coils	12	12
Timers/counters [4 digit] ¹	64	64
Shift registers [steps]	128	128
Data registers [16 bit]	64	64
Sequencers [9999 step] ²	64	64
Compatible programming environment		
TISOFT IBM PC software	Y	Y
Hand-Held Programmer	Y	Y
Portable Programmer	Y	Y
I/O		
Base density	5/8/10	5/8/10
Module density	4/8/16	4/8/16
Analog I/O ³	24	24
Remote I/O distance	3300'	3300'
Remote I/O points	96	96
Battery life [typical]	5 years	5 years
CPU models available	325-07	330-07

¹ Any mix of timers or counters
² Implemented using counters
³ Six 16-point references per system



UDC 3000 Versa-Pro

Universal Digital Controller

The only 1/4 DIN controller with the functionality and operating simplicity of controllers twice its size and cost. Thousands of units currently in operation attest to its acceptance by industry.

Honeywell's UDC 3000 Universal Digital Controller packs all the right features in a 1/4 DIN size box to meet the control needs of virtually any application in any industry.

Microprocessor based and field configurable, UDC 3000 is an ideal controller for regulating temperature and other process variables in numerous heating and cooling applications in metalworking, food and pharmaceuticals, and testing and environmental work.

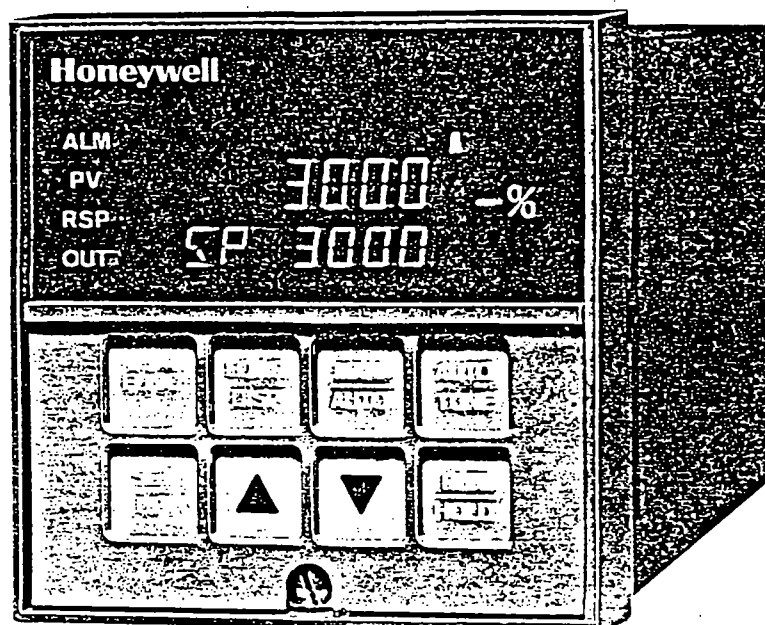
With an accuracy of $\pm 0.20\%$ of span and a precision and repeatability you can rely on, UDC 3000 is easy to install, configure and operate. Dedicated vacuum fluorescent displays with English language prompts lead you through configuration and keep you informed at all times of up-to-the-minute process conditions.

UDC 3000's universal input capability accepts thermocouple, RTD, mA, mV or volts to control virtually any process variable. Control outputs can be time, current or position proportional and they can be configured for On-Off, PID-A, PID-B or PD with manual reset. Transfer between automatic and manual operation is bumpless. A tactile keyboard provides positive operator feedback.

The UDC 3000 is environmentally hardened and can be mounted virtually anywhere in plant or factory, on the wall or in panel, or even on the process "machine." It withstands ambient temperatures between up to 55°C and resists the effects of vibration and mechanical shock.

Self-diagnostics, fault-tolerant design and keyboard security provide maximum assurance of trouble-free operation.

The quality of the Versa-Pro is assured by a rock-solid 2 year warranty program which features replacement units in the event of malfunction. Comprehensive customer support includes a toll-free telephone "Help" number for "button pushing" problems.



FEATURES AND BENEFITS

- **Dedicated displays** Vacuum fluorescent displays, with English prompts, keep you informed of up-to-the-minute process conditions: a deviation bargraph indicates deviation (up to 10%) between setpoint and process variable.
- **Universal isolated inputs** Accepts thermocouple, RTD, mA, mV and volts: all inputs are configurable — no need to calibrate.
- **Easy configuration** English language prompts lead you through configuration in a logical sequence.
- **Alarms** 1 or 2 fully configurable alarms alert you to critical process conditions.
- **Setpoint ramp** Single programmable setpoint ramp up to 4-1/4 hours adds to startup flexibility.
- **Square root extractor** This standard feature, in combination with available 24 volt transmitter power, provides a cost effective solution for flow applications.
- **Control algorithms** Configurable for On-Off, PID-A, PID-B or PD with manual reset.
- **Control outputs** Time, current or position proportioning, as specified.
- **Heat/cool capability** Provides split range control with independent PID tuning constants for heating and for cooling, plus mixed output forms.
- **Limit control** A latching relay is activated whenever the PV goes above or below a preset value.

CONDENSED SPECIFICATIONS

Accuracy

± 0.20 % of span.

Inputs

Thermocouples (type B, E, J, K, N, R, S, T, W5W26); RTD's (100 and 500Ω Platinum); Voltages/Current (0-10 mV, 10-50 mV, 1-5V, 0-10V, 4-20 mA).

Control outputs

Time, current or position proportioning, as specified.

Control algorithms

Configurable for On-Off, PID-A, PID-B and PD with manual reset.

Tuning parameters

Gain or PB (%), 0.1 to 999.9 minutes; Rate, 0.08 to 10 minutes; Reset, 0.02 to 50.00 minutes/repeat or repeats/minute.

Power requirements

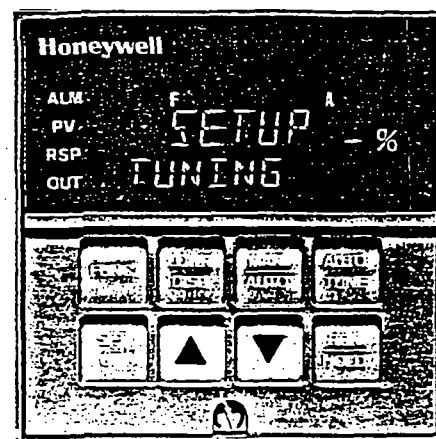
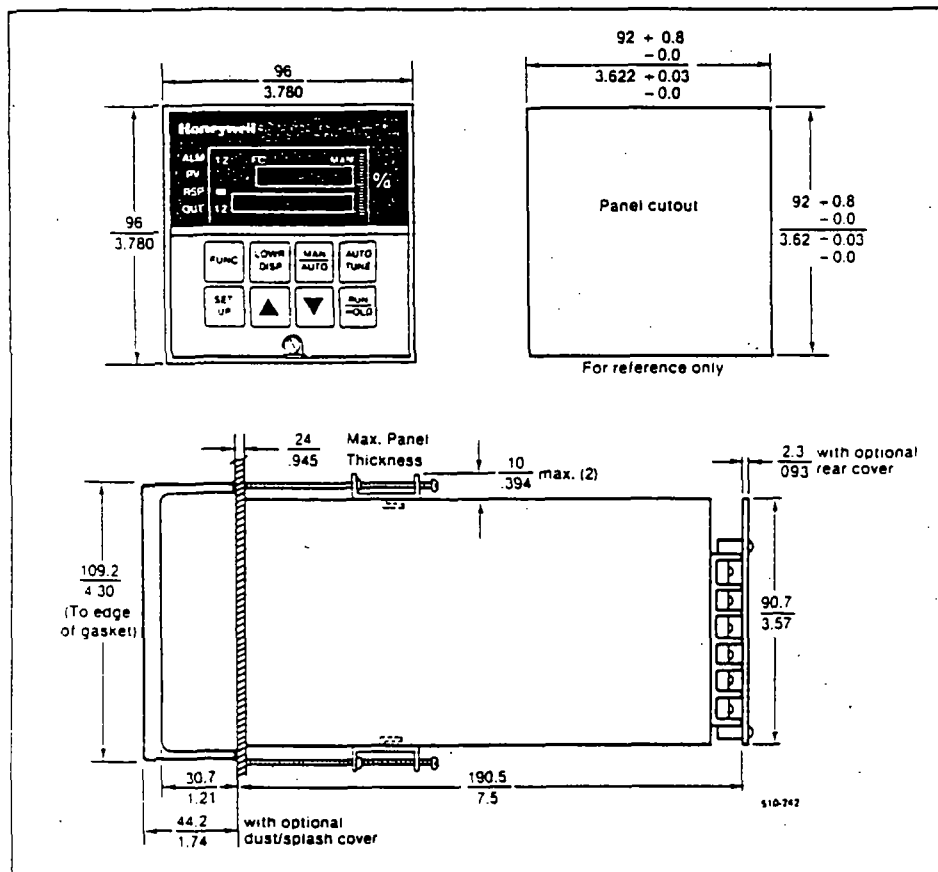
120/240 volts, 50 or 60 Hz.

Warranty and technical assistance

UDC 3000 carries a 2-year warranty, backed up by unmatched service, support capability and a toll-free 800 number for technical assistance.

ORDERING INFORMATION

For complete ordering information, request Model Selection Guide 51-51-03-07 for the UDC 3000 Versa-Pro. Honeywell offers a full line of Sensors, Transmitters, and Final Control Devices for use with the Versa-Pro and other Pro-Series controllers. These devices include: Thermocouples, RTDs, Digital Panel Indicator, Pressure Transmitters, Flow Transmitters, Liquid Level Transmitters, Valves, Actuators and Electric Motors. If you require greater accuracy and advanced control functions, ask your Honeywell representative about the new UDC 5000 Ultra-Pro.



Dedicated displays and English language prompts keep you informed of process conditions and lead you through configuration in a programmed sequence.

Honeywell

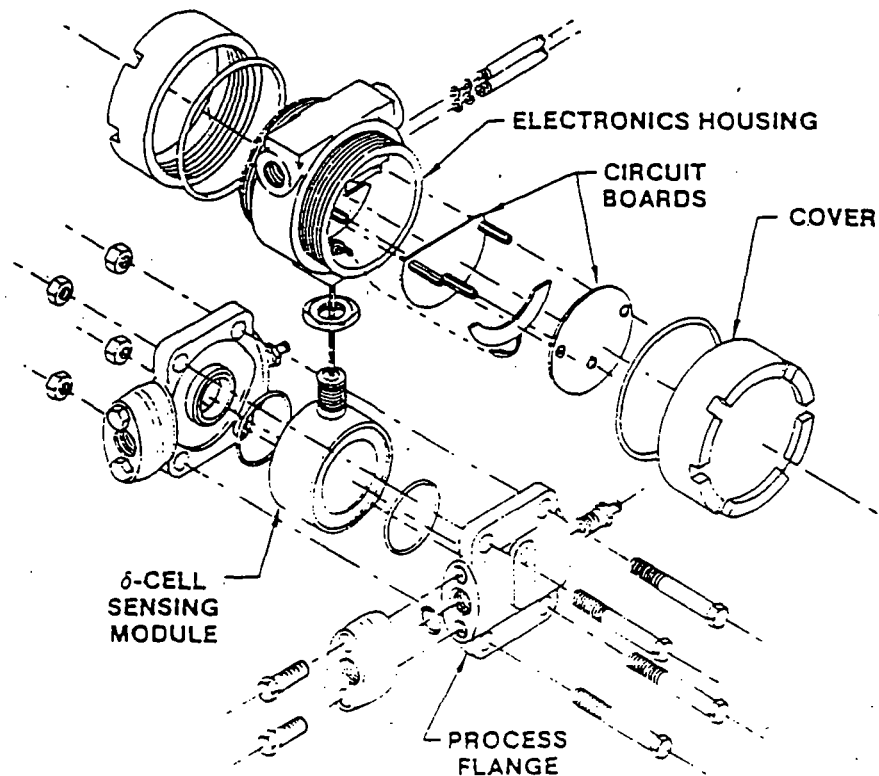
HELPING YOU CONTROL YOUR WORLD

Industrial Controls Division, 1100 Virginia Drive, Fort Washington, PA 19034

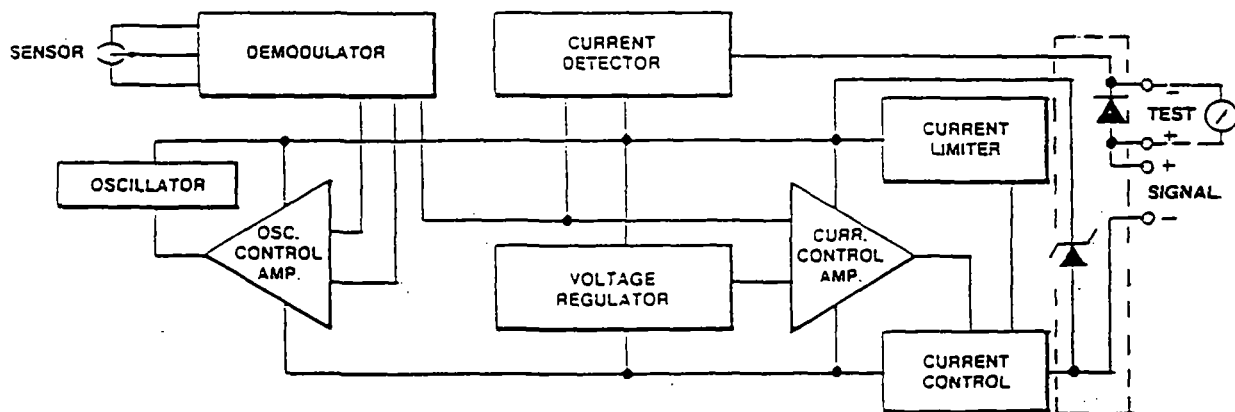
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All specifications subject to change without notice

TYPICAL MODEL 1151 PRESSURE TRANSMITTER ASSEMBLY

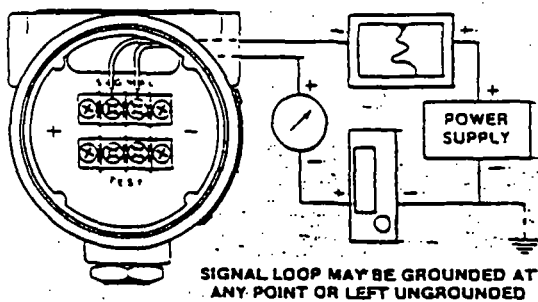


ELECTRICAL BLOCK DIAGRAM



NOTE: DASHED LINE ENCLOSURES REVERSE POLARITY CIRCUITRY.

WIRING CONNECTIONS



Standard Accessories

All models are shipped with flange adapters, vent/drain valves and one instruction manual per shipment.

Tagging

Alphaline® Differential Pressure Transmitters will be tagged in accordance with customer requirements. Customer tag is 0.018 in. (0.051 cm) thick with 0.125 in. (0.318 cm) high letters. All tags are stainless steel.

Calibration

Transmitters are factory calibrated to customer's specification. If calibration is not specified, transmitters are calibrated at maximum range. Calibration is at ambient temperature and pressure.

SPECIFICATIONS

FUNCTIONAL SPECIFICATIONS

Service

Liquid, gas, and vapor.

Ranges

0-5 to 0-30 inH₂O (0-1.24 to 0-7.46 kPa)
0-25 to 0-150 inH₂O (0-6.22 to 0-37.29 kPa)
0-125 to 0-750 inH₂O (0-31.08 to 0-186.45 kPa).

Outputs

4-20 mA dc or 10-50 mA dc.
Smart 4-20 mA dc (See PDS 2593).
1-5 V dc Low Power (See PDS 2447).

Power Supply

External power supply required.
4-20 mA dc: Transmitter operates on 12 to 45 V dc with no load.
10-50 mA dc: Transmitter operates on 30 to 85 V dc with no load.
1-5 V dc: Transmitter operates on 8 to 12 V dc with no load.

Load Limitations

See Figure 1.

Indication

Optional meter with 2 in. (50.8 mm) scale.
Indication accuracy is $\pm 2\%$.

Hazardous Locations

Factory Mutual (FM) Approvals

Explosion Proof: Class I, Divisions 1 and 2, Groups B, C, and D; Dust-Ignition Proof: Class II, Divisions 1 and 2, Groups E, F, and G; Suitable For Use In: Class III, Divisions 1 and 2. Indoor and outdoor use. NEMA 4X.

Canadian Standards Association (CSA) Approvals

Certified for Class I, Division 2, Groups A, B, C and D; Class I, Division 1, Groups C and D; Class II, Divisions 1 and 2, Groups E, F, and G; Class III hazardous locations: CSA enclosure 4, factory sealed.

Intrinsic Safety Approvals

FM and CSA certifications optional for specific Classes, Divisions, and Groups when connected with approved barrier systems. See summary in PDS 2360.

FM explosion proof tag is standard. Appropriate tag will be substituted if optional certification is selected.

Span and Zero

Continuously adjustable externally.

Zero Elevation and Suppression

Regardless of output specified, zero elevation and suppression must be such that neither the span nor the upper or lower range value exceed 100% of the upper range limit.

Maximum zero elevation is 600% of calibrated span.
Maximum zero suppression is 500% of calibrated span.

Temperature Limits

-20 to +200 °F (-29 to +93 °C) Amplifier operating.
-40 to +220 °F (-40 to +104 °C) Sensing element operating with silicone fill.
+32 to +160 °F (0 to +71 °C) Sensing element operating with inert fill.
-60 to +250 °F (-51 to +121 °C) Storage.

Static Pressure and Overpressure Limits

0 psia to 2000 psig (0 to 13.79 MPa) on either side without damage to the transmitter.
Operates within specifications between static line pressures of 0.5 psia and 2000 psig (3.44 kPa to 13.79 MPa) for silicone oil transmitters, and between atmospheric and 2000 psig (13.79 MPa) for inert fill transmitters.
10,000 psig (68.95 MPa) proof pressure on the flanges.

Humidity Limits

0 to 100% relative humidity.

Volumetric Displacement

Less than 0.01 cubic in. (0.16 cm³).

Damping

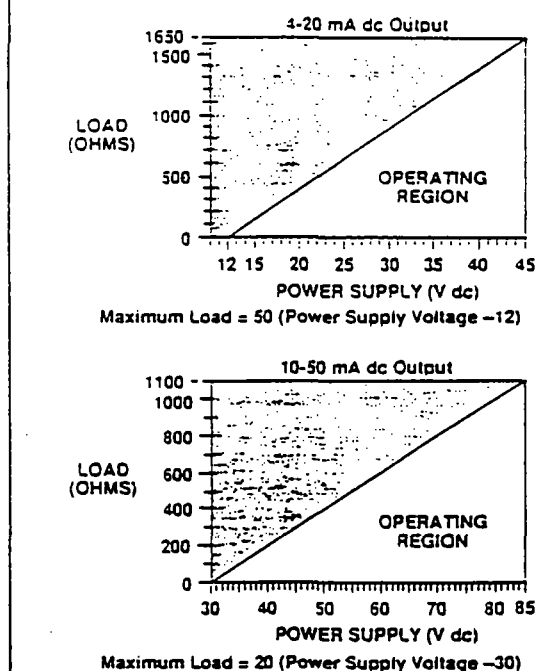
Time constant continuously adjustable between 0.2 and 1.67 seconds with silicone fill.

Inert fill: Higher time constant.

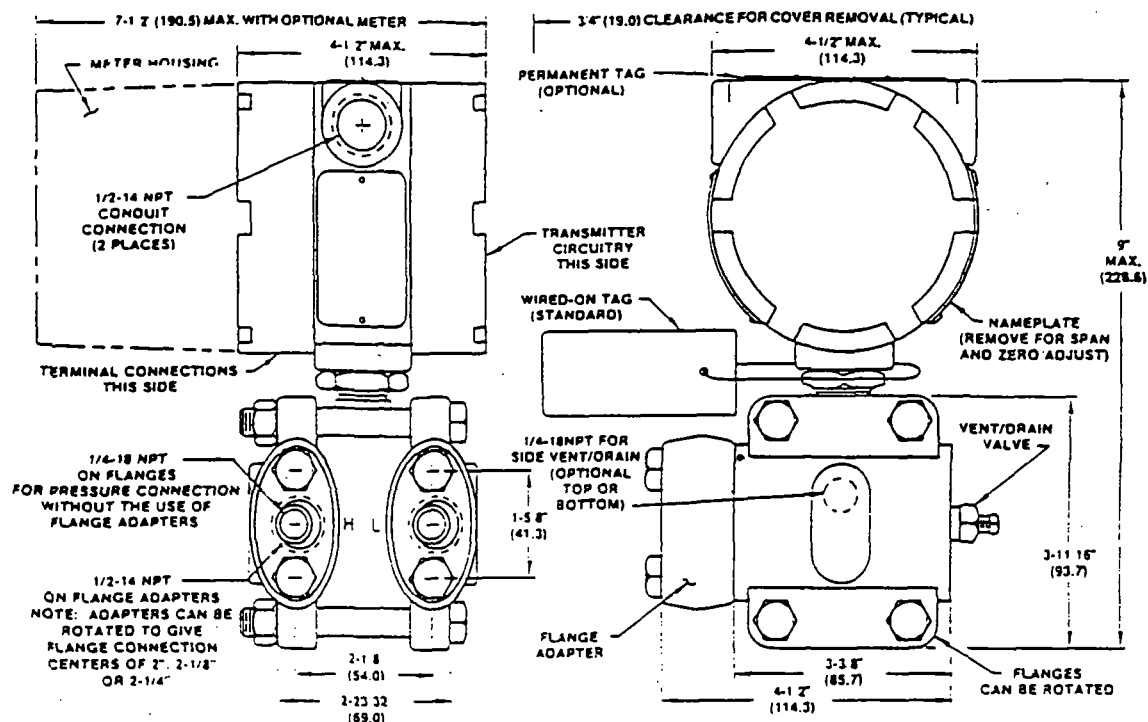
Turn-on Time

2 seconds. No warmup required.

FIGURE 1
LOAD LIMITATIONS

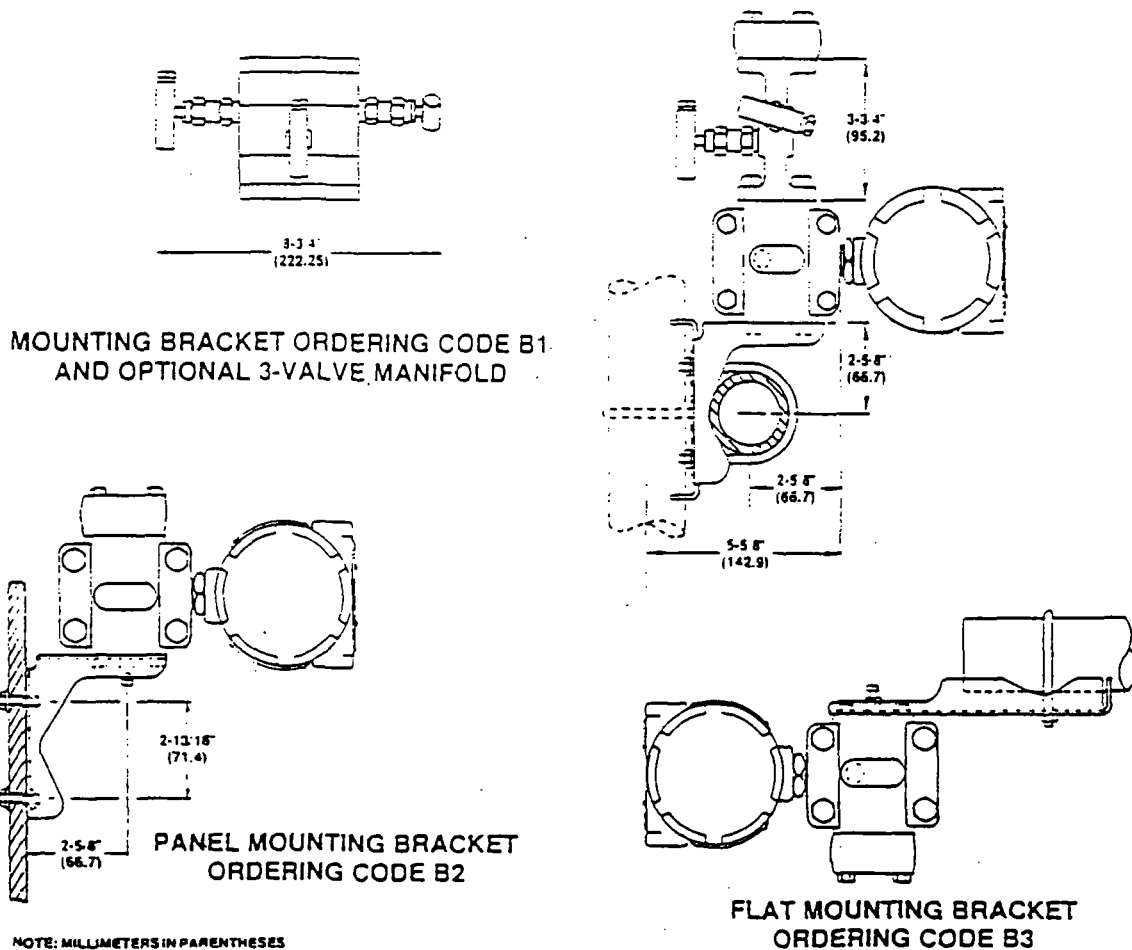


DIMENSIONAL DRAWINGS



NOTE: MILLIMETERS IN PARENTHESES

OPTIONAL MOUNTING BRACKETS SHOWN IN TYPICAL MOUNTING CONFIGURATIONS



NOTE: MILLIMETERS IN PARENTHESES

PERFORMANCE SPECIFICATIONS

(Zero-based spans, reference conditions, silicone oil fill, 316 SST isolating diaphragms)

Accuracy

$\pm 0.2\%$ of calibrated span. Includes combined effects of linearity, hysteresis and repeatability.

Linearity

$\pm 0.1\%$ calibrated span.

Hysteresis

0.05% of calibrated span (0.1% for Range 5).

Dead Band

None.

Stability

$\pm 0.2\%$ of upper range limit for 6 months.

Temperature Effect

At maximum span: e.g., 0-150 inH₂O (0-37.29 kPa) for Range 4.

Zero Error: $\pm 0.5\%$ of span per 100 °F (55 °C).

Total effect including span and zero errors: $\pm 1.0\%$ of span per 100 °F (55 °C).

Note: Double the specified effect for Range 3.

At minimum span: e.g., 0-25 inH₂O (0-6.22 kPa) for Range 4.

Zero Error: $\pm 3.0\%$ of span per 100 °F (55 °C).

Total effect including span and zero errors: $\pm 3.5\%$ of span per 100 °F (55 °C).

Note: Double the specified effect for Range 3.

Static Pressure Effect

Zero Error: $\pm 0.25\%$ of upper range limit for 2000 psi (13.79 MPa). $\pm 0.5\%$ for Range 3. Correctable through rezeroing at line pressure.

Span Error: Correctable to $\pm 0.25\%$ of reading per 1000 psi (6.9 MPa), or to $\pm 0.5\%$ of reading per 1000 psi (6.9 MPa) for Range 3.

Vibration Effect

$\pm 0.05\%$ of upper range limit per g to 200 Hz in any axis.

Power Supply Effect

Less than 0.005% of output span per volt.

Load Effects

No load effect other than the change in power supplied to the transmitter.

Mounting Position Effect

Zero shift of up to 1 inH₂O (0.24 kPa) which can be calibrated out. No span effect. No effect in plane of diaphragm.

PHYSICAL SPECIFICATIONS

Materials of Construction†

Isolating Diaphragms

316L SST, Hastelloy C-276, Monel or tantalum.

Drain/Vent Valves

316 SST, Hastelloy C, or Monel.

Process Flanges and Adapters

Nickel or cadmium-plated carbon steel, 316 SST, Hastelloy C, or Monel.

Wetted O-rings

Viton. (Other materials also available)

Fill Fluid

Silicone oil or inert fill.

Bolts and Conduit Plug

Cadmium-plated carbon steel.

Electronics Housing

Low-copper aluminum. NEMA 4X.

Paint

Epoxy-polyester.

Process Connections

1/4 NPT on 2-1/8 in. (5.4 cm) centers on flanges. 1/2 NPT on 2 (5.08 cm), 2-1/8 (5.4 cm), or 2-1/4 in. (5.72 cm) centers with adapters.

Electrical Connections

1/2 in. conduit with screw terminals and integral test jacks compatible with miniature banana plugs (Pomona 2944, 3690 or equal).

Weight

12 pounds (5.44 kg) excluding options.

A-Cell, Algonline, and Rosemount are registered trademarks of Rosemount Inc.

Terminology per SAMA Standard PMC20.1-1973.

†Monel is a trademark of International Nickel Co.

Hastelloy is a trademark of the Cabot Corp.

Viton is a trademark of E.I. Du Pont de Nemours & Co.

Series A and LT

Butterfly Valves

General

Economy and efficiency influence the design of both our Series "A" and "LT" valves. As in all Center Line valves, rugged construction, ease of operation and **LONG MAINTENANCE-FREE LIFE** are built in. Quality standard features include the cast iron body, 1045T carbon steel (phosphate coated) shaft and luberized bronze or Teflon bushings. All A's and LT's will accommodate a minimum of 2" of pipeline insulation. Both are ideal for on-off or throttling operations, depending on your requirement. Center Line valves exhibit equal percentage flow characteristics and perform well in control applications.

Materials of Construction

- The temperature limits of elastomer seated valves are -30°F to +400°F depending on the elastomer selected for the application.
- Operators can be mounted in any quadrant relative to the valve — parallel or perpendicular to the pipeline per your specification.
- A/LT valves are rateable for tight shutoff to:

2"-12"	200 PSI
14"-30"	150 PSI
Teflon Seats	125 PSI
PVF Discs	150 PSI
- ASTM numbers of materials can be found in Engineering Section of our master catalog.

Series A

The Series "A" is our standard wafer style, designed for installation between two pipe flanges. The valve is centered within the flange bolts passing through both flanges.

Series LT

The Series "LT" valve has a full lug body with bolt holes threaded to provide a positive alignment of the valve between mating flanges. On each flange, short bolts pass through the flange and thread into the tapped holes in the corresponding valve lugs. The valve can thus remain bolted to one pipe flange while the other flange is removed. Series "LT" valves 2"-12" may be ordered for unidirectional dead-end

service (no extra cost) to full pressure shutoff rating with or without use of a downstream flange. Sizes 14" and larger may be used for dead end service with downstream flange; if needed without downstream flange, consult factory.

BODY		DISC	SHAFT	BUSHINGS
Cast Iron	Ductile Iron	Ductile Iron	Carbon Steel	Reinforced Teflon
Cast Steel	316 S.S.	316 S.S.	(phosphate coated)	
316 S.S.	Monel	Monel	316 S.S.	
Abrasion Coating	Teflon	Teflon	316 S.S.	
	PVF ¹ Coating			
SEAT				
MATERIAL		TEMPERATURE RATINGS ³		
		Continuous	Intermittent	
Buna N		-10 to 180	+10 to 200	
Abrasive Resistant Buna N		-10 to 180	+10 to 200	
White Neoprene		-20 to 200	+20 to 225	
EPDM (2"-16")		-30 to 275	+40 to 300	
EPDM (18"-30")		-30 to 225	+40 to 250	
Hypalon		0 to 275	0 to 300	
Fluorel ²		+10 to 275	+10 to 300	
Fluorel ² -epoxy backing		+10 to 400	+10 to 425	
Teflon over Buna-N		+40 to 225	+40 to 250	

- PVF: Polyvinylidene Fluoride, sometimes referred to as Kynar, a registered trademark of Penwalt. Chemical resistance approximately equal to Teflon, plus excellent abrasion resistance. Available for chemical or corrosion resistance on 2"-12" internal drive only, abrasion resistance only on 14"-20" sizes. Not available with Teflon seat.
- Fluorel is commonly referred to as Vitron[®] Registered trademark of DuPont. Fluorel is 3M's equivalent.
- Consult factory for service temperatures below those listed. Seat materials are capable of withstanding lower temperatures without damage. However, the elastomer becomes hard and torques increase.

Other Materials Available Upon Special Request — Consult Factory

A Look Inside

Actuator Flange: Accommodates all types of actuators; manual, gear, electric, hydraulic and pneumatic actuators.

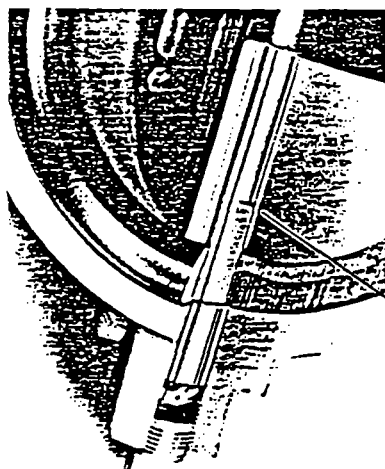
Pressure Surge Seals: These seals are molded inside the seat shaft hole area. These rings are an integral part of the seat to provide failsafe sealing around the shaft eliminating possible leakage.

Smooth Finished Disc Flats: These "mate" with seat flats to give a highly efficient seal; prevents leakage into the shaft area.

Precision Profile Disc: Provides bubble-tight shutoff with minimal disc/seat interference, assuring minimum torque and longer seat life.

Seat Face: Negates need for flange gaskets

Supported Shaft Seal: Bonding of elastomer to phenolic backing ring protects against distortion, a common cause of shaft leakage.



Bushing

The Phenolic Backed Seat: Non-collapsible, stretch resistant, blowout proof, and easily field replaceable.

Optional Internal Drive: In lieu of standard taper pin connection, for food and beverage, coated disc, and other applications.

Shaft Weather Seal

Strong Precision Key: Gives positive attachment for manual lever or actuator.

Bushings (Teflon): Give shaft support at actuator mounting and immediately outboard of seat

Precision Taper Pins: Ensure positive, vibration proof, shaft to disc connection. Easily field replaceable.

Valves available with both Wafer and Lug Type Bodies: Fully lined body in a broad range of materials—including Teflon.

One Piece Thru-Shaft: Design ensures dependability and positive disc control.

Alignment Features: Allow easy installation between pipeline flanges; a real installation cost saver. ANSI 125/150 bolt pattern standard; others available.

Totally Bidirectional when installed between two flanges. 2"-12" lug style provides unidirectional dead-end service.

Valve sizes 2"-20" have passed AWWA C-504-80 Section 5 proof of design tests.

Technical Data

Seating Torques FOR ACTUATOR SIZING (SERIES ALT VALVES)

VALVE SIZE IN INCHES	SEAT MATERIAL BUNA-EPDM-HYPALON		SEAT MATERIAL NEOPRENE-FLUOREL	
	WET SERVICE	DRY SERVICE	WET SERVICE	DRY SERVICE
	STANDARD SHUTOFF* — STANDARD DISC			
2	117	156	137	183
2½	189	252	221	295
3	244	325	285	381
4	390	520	456	608
5	598	797	700	933
6	875	1167	1024	1365
8	1430	1907	1673	2231
10	2275	3033	2262	3549
12	3250	4333	3802	5070
14	3738	4984	4373	5831
16	7527	10036	8807	11742
18	9646	12861	11286	15048
20	10010	13347	11712	15616
24	20566	27421	24062	32083
30	31532	42043	36892	49190

*200 PSI 2"-12" 150 PSI 14"-30"

VALVE SIZE IN INCHES	SEAT MATERIAL BUNA-EPDM-HYPALON		SEAT MATERIAL NEOPRENE-FLUOREL	
	WET SERVICE	DRY SERVICE	WET SERVICE	DRY SERVICE
	STANDARD SHUTOFF* — STANDARD DISC			
8	880	1173	1030	1373
10	1381	1841	1616	2154
12	2200	2933	2574	3432
	50 PSI SHUTOFF — UNDERSIZED DISC			
14	2620	3493	3065	4087
16	5265	7020	6160	8213
18	6754	9005	7902	10536
20	7007	9343	8198	10931
24	14424	19232	16876	22501
30	22074	29432	25827	34435

NOTES:

- All torques shown are for on-off service. For modulating service, multiply by 1.25.
- Based on ambient temperatures — 40° to 200°F except for Fluorel, which is based on — 70° to 300°F. Torques increase substantially below these limits. If valve is to be turned at lower temperature, consult your rep or the factory for further torque information.
- For valves ≥ 14" and wet service fluid velocities > 12 fps, dynamic torques may exceed seating torques. Consult factory.
- Figures have reasonable safety factors included for normal service conditions. For special applications, consult Center Line.
- For three-way assemblies, multiply by 1.3.

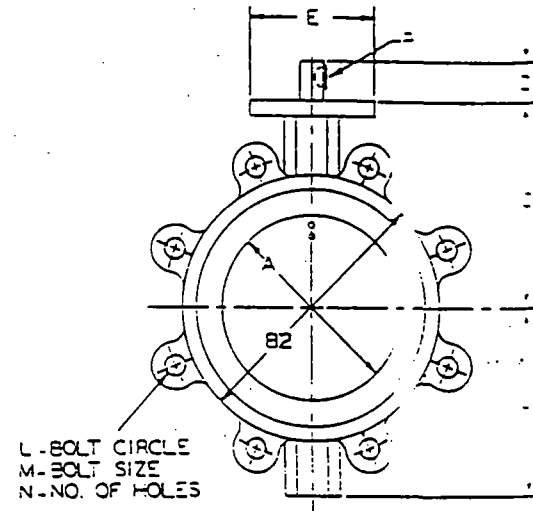
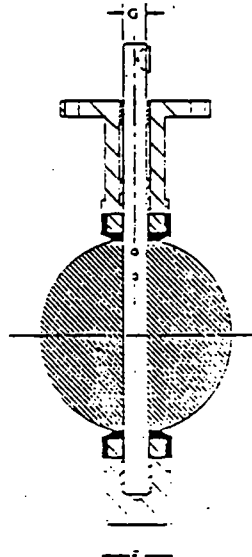
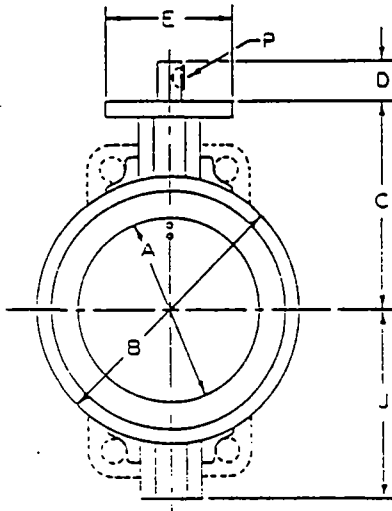
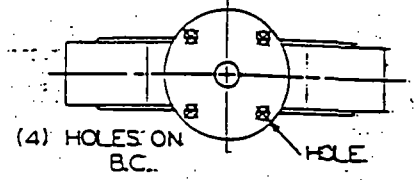
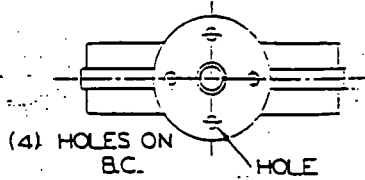
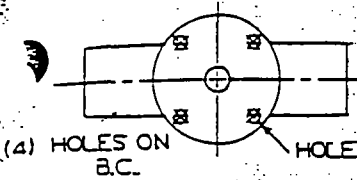
Butterfly Valve Sizing Coefficients — Series A and LT

VALVE SIZE IN INCHES	COEFFICIENT OF VOLUME CV (GPM AT 100 PSI) DISC OPENING IN DEGREES								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
2	0.06	3	7	15	27	44	70	105	115
2½	0.10	6	12	25	45	75	119	178	196
3	0.20	9	18	39	70	116	183	275	302
4	0.30	17	36	78	139	230	364	546	600
5	0.50	29	61	133	237	392	620	930	1022
6	0.80	45	95	205	366	605	958	1437	1579
8	2	89	188	408	727	1202	1903	2854	3136
10	3	151	320	694	1237	2047	3240	4859	5340
12	4	234	495	1072	1911	3162	5005	7507	8250
14	6	338	715	1549	2761	4568	7230	10844	11917
16	8	464	983	2130	3797	6282	9942	14913	16388
18	11	615	1302	2822	5028	8320	13168	19752	21705
20	14	791	1674	3628	6465	10698	16931	25396	27908
24	22	1222	2587	5605	9989	16528	26157	39236	43116
30	37	2080	4406	9545	17010	28147	44545	66818	73426

Series "A" 2"-12"

Series "A" & "LT" 14"-30"

Series "LT" 2"-12"



Wafer Body

Valve may be furnished with or without drilled alignment lugs. Interchangeability not effected.

F Dim. is elastomer shown in relaxed condition approx. 1/4" total compression req'd. for seal.

Center Line Valves do not require flange gaskets. The use of flange gaskets will void all valve warranties.*

Lug Body

VALVE SIZE	A	B	B2	C	D	E	F	G	HOLE 12-B.C.	BOLT 62	J	J2	L	M	N	P	STAINLESS STEEL WT.	STAINLESS STEEL WT.
2	2 50.8	3 1/2 88.9	3 1/2 88.9	4 1/2 104.78	1 1/4 31.75	4 101.6	1 3/4 44.45	1/2 12.7	3/8-3/4	3/4 9.53	3 3/8 80.96	3 3/8 80.96	4 1/2 120.65	1/2-11 15.88-279.40	4	NO. 3 woodruff	5 2.27	7 3.17
2 1/2	2 1/2 63.5	4 101.6	4 101.6	4 1/2 117.48	1 1/4 31.75	4 101.6	1 1/2 47.63	1/2 12.7	3/8-3/4	3/4 9.53	3 3/8 87.31	3 3/8 87.31	5 1/2 139.70	1/2-11 15.88-279.40	4	NO. 3 woodruff	5 2.27	8 3.63
3	3 1/8 79.38	4 1/4 123.83	4 1/4 123.83	4 1/2 123.83	1 1/4 31.75	4 101.6	1 1/2 47.63	1/2 12.7	3/8-3/4	3/4 9.53	3 3/8 95.25	3 3/8 95.25	6 152.4	1/2-11 15.88-279.40	4	NO. 3 woodruff	7 3.17	9 4.08
4	4 1/8 104.78	5 1/8 157.16	5 1/8 157.16	6 152.4	1 1/4 31.75	4 101.6	2 1/8 54.00	3/4 19.05	3/8-3/4	3/4 9.53	4 1/8 111.13	4 1/8 111.13	7 1/2 190.50	1/2-11 15.88-279.40	8	NO. 9 woodruff	11 4.99	17 7.71
5	4 1/2 123.83	7 1/8 180.98	7 1/8 180.98	6 152.4	1 1/4 31.75	4 101.6	2 1/4 57.15	3/4 19.05	3/8-3/4	3/4 9.53	5 127.0	5 127.0	8 1/2 215.90	1/2-10 19.05-254.00	8	NO. 9 woodruff	13 5.89	20 9.07
6	5 1/8 158.75	8 1/8 211.14	8 1/8 211.14	6 1/2 165.1	1 1/4 31.75	4 101.6	2 1/4 57.15	3/4 19.05	3/8-3/4	3/4 9.53	5 1/2 149.23	5 1/2 149.23	9 1/2 241.30	1/2-10 19.05-254.00	8	NO. 9 woodruff	18 8.16	25 11.33
8	7 1/8 203.2	10 1/8 261.94	10 1/8 261.94	8 1/2 214.31	1 1/4 44.45	6 152.4	2 1/2 63.5	7/8 22.23	1/2-5	1/2 12.7	7 177.8	7 177.8	11 1/4 298.45	1/2-10 19.05-254.00	8	NO. 9 woodruff	28 12.69	39 17.68
10	9 1/8 250.8	12 1/8 320.68	12 1/8 320.68	9 1/2 244.48	1 1/4 44.45	6 152.4	2 3/4 69.85	1 1/8 28.58	1/2-5	1/2 12.7	8 1/4 212.73	8 1/4 212.73	14 1/4 361.95	1/2-9 22.23-228.60	12	NO. 15 woodruff	38 17.23	57 25.84
12	11 1/8 301.6	14 1/4 374.65	14 1/4 374.65	11 3/8 284.16	1 1/4 44.45	6 152.4	3 1/8 79.40	1 1/4 31.75	1/2-5	1/2 12.7	9 3/8 238.13	9 3/8 238.13	17 431.80	1/2-9 22.23-228.60	12	NO. 15 woodruff	50 22.67	80 36.27
14	13 1/8 333.38	17 1/4 434.98	17 1/4 447.68	14 1/2 368.3	1 1/4 44.45	5 1/2 139.7	3 3/4 79.40	1 1/4 31.75	1/2-4 1/2	1/2 12.7	10 1/8 266.7	11 279.40	18 1/2 476.25	1-8 25.40-203.20	12	NO. 15 woodruff	95 43.09	155 70.31
16	15 1/8 390.53	20 508.0	20 1/8 511.18	15 3/4 400.05	2 50.8	8 196.85	3 1/2 88.9	1 3/8 33.34	1/2-6 1/2	3/4 19.05	11 3/8 298.45	12 304.80	21 1/4 539.75	1-8 25.40-203.20	16	1/4" Sq. 7.94 Sq.	117 53.07	195 88.45
18	17 1/8 441.33	21 1/8 542.93	20 3/4 527.05	16 1/8 422.28	2 50.8	8 196.85	4 1/4 107.95	1 1/2 38.1	1/2-6 1/2	3/4 19.05	12 1/8 311.15	15 1/4 361.95	22 3/4 577.85	1 1/2-7 28.58-177.80	16	3/4" Sq. 9.53 Sq.	165 74.84	230 104.33
20	19 1/8 492.13	23 1/8 592.14	23 1/8 596.90	18 1/8 479.43	2 1/4 63.5	7 3/4 196.85	5 1/8 133.35	1 3/4 41.28	1/2-6 1/2	3/4 19.05	13 3/8 349.25	15 1/4 368.30	25 635.00	1 1/2-7 28.58-177.80	20	1/2" Sq. 9.53 Sq.	275 124.74	396 179.62
24	23 1/8 590.55	27 1/8 711.2	27 1/8 708.03	22 1/8 561.98	2 3/4 69.85	11 1/4 276.23	8 1/4 155.58	2 50.8	1/2-8 1/2	3/4 19.05	16 1/8 409.58	18 1/4 469.90	29 1/2 749.30	1 1/2-7 31.75-177.80	20	1/2" Sq. 12.7 Sq.	440 199.58	610 276.70
30	29 1/8 746.13	34 1/8 879.48	33 1/2 850.90	25 1/2 647.7	3 1/4 82.55	11 1/4 276.23	6 3/4 171.45	2 1/4 63.5	1/2-8 1/2	3/4 19.05	19 1/8 495.3	24 1/4 603.25	38 914.40	1 1/2-7 31.75-177.80	28	1/2" Sq. 15.88 Sq.	740 335.66	1050 476.27

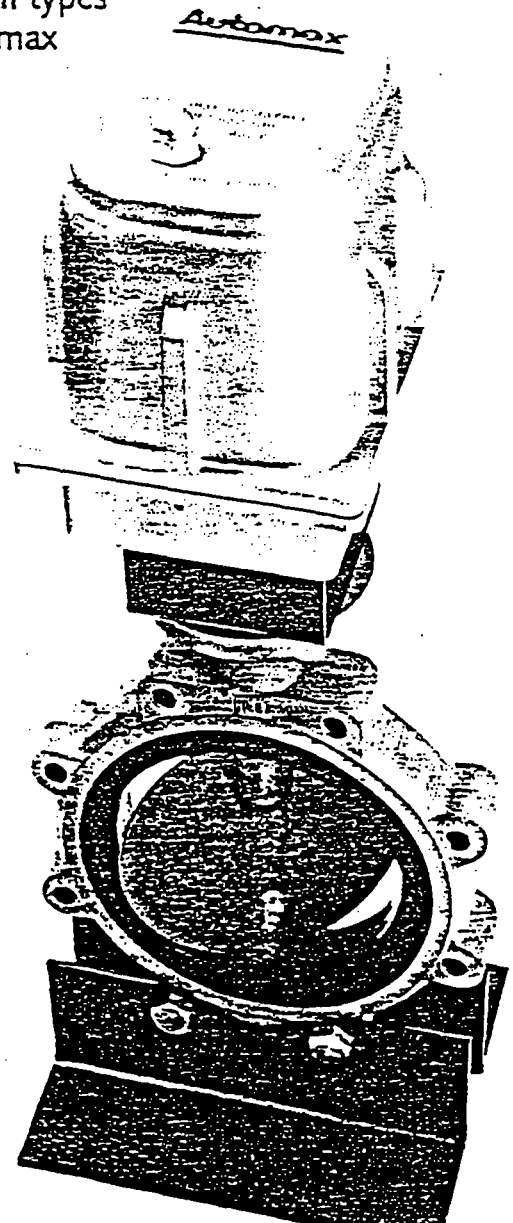
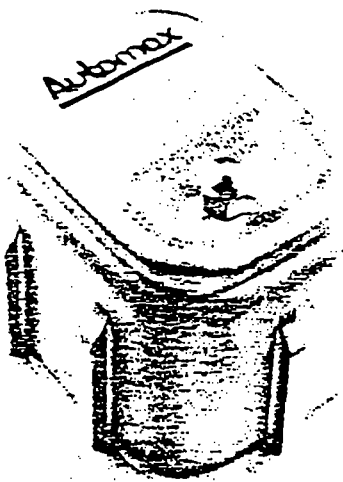
* Center Line wafer, lug, and check valves are designed for installation between ANSI iron or steel flanges. Gaskets are not needed, and should not be used, since the seat face seals against the mating flange. If the valve is to be installed in plastic or fiberglass flanges or flange rings, consult your Center Line agent or the factory for more information.



Electric Actuators



Automax Electric Actuators provide precise, dependable control of quarter-turn valves, dampers, flow controls and other rotary devices. Automax Actuators are used in all areas of industry including chemical processing, power, gas and oil, HVAC and marine. The simple, yet rugged design results in a compact package which produces torque up to 3500 inch pounds. Automax additionally designs electric actuator systems to customer specifications. And, our engineering department develops valve mounting hardware for all types of ball, butterfly and plug valves. Consult your Automax representative today for the best value in actuation!



Technical Data

Model	Action	Torque (in lbs)	Cycle Time ^a per 90°	Voltage ^b ③	Locked Rotor Amps 115VAC	Switches	Motor Brake	Manual Override	Approx. Weight
E98.6*	Reversible	100	3.5 sec.	115VAC, 60Hz	.6	2 Spdt (Std) 5 Amps	Standard	N/A	3.7#
E300-12	Reversible	300	7.5 sec.	115VAC, 60Hz	1.0	2 Spdt (Std) 10 Amps	Standard	Optional	10#
E600-12	Reversible	600	15 sec.	115VAC, 60Hz	1.0	2 Spdt (Std) 10 Amps	Standard	Standard	14#
E1000-12	Reversible	1000	5 sec.	115VAC, 60Hz	3.0	2 Spdt (Std) 10 Amps	Standard	Standard	34#
E1500-12	Reversible	1500	6 sec.	115VAC, 60Hz	3.0	2 Spdt (Std) 10 Amps	Standard	Standard	36#
E3500-12	Reversible	3500	15 sec.	115VAC, 60Hz	3.0	2 Spdt (Std)	Standard	Standard	38#

Basic Options

Voltages

12 V.D.C.

24 V.D.C.

Other voltages,
consult factory

Limit Switches (2 spdt standard)

Model	Additional Switches Available
-------	----------------------------------

E98.6	2
-------	---

E300	1
------	---

E600	2
------	---

E1000	2
-------	---

E1500	2
-------	---

E3500	2
-------	---

Feedback Potentiometer

0-135 Ohm (Over 90° Nominal)

0-1000 Ohm (Over 90° Nominal)

0-5000 Ohm (Over 90° Nominal)

1-10,000 Ohm (Over 90° Nominal)

Heater and Thermostat

25 Watt Heater

70°F Standard Thermostat

Control Relay

2 Wire Control

Pilot

Controls

Manual-Off-Auto

Local-Remote

Position Indication

Travel Indication

Potentiometer

Open-Close

Customized Controls Available

Speed Control

Variable Speed Control

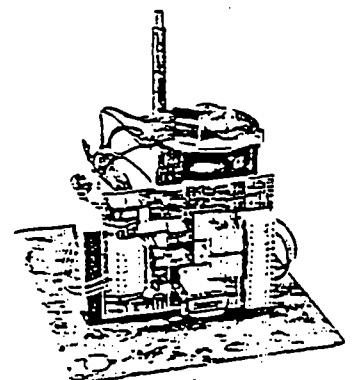
Positioner

ESP (Electronic Servo Positioner)

See Page 5

Housing

Nema 4-Weatherproof



ESP Positioner

The new Automax ESP Electronic Positioner for precise modulating control features the latest advancements in electronics for precise positioning of electric actuators.

When used in conjunction with Automax Electric Actuators, the ESP accomplishes valve positioning in response to variable signals generated by process monitoring devices including flow meters, liquid level sensors, pH sensors, programmable controllers and computers.

Principle of Operation

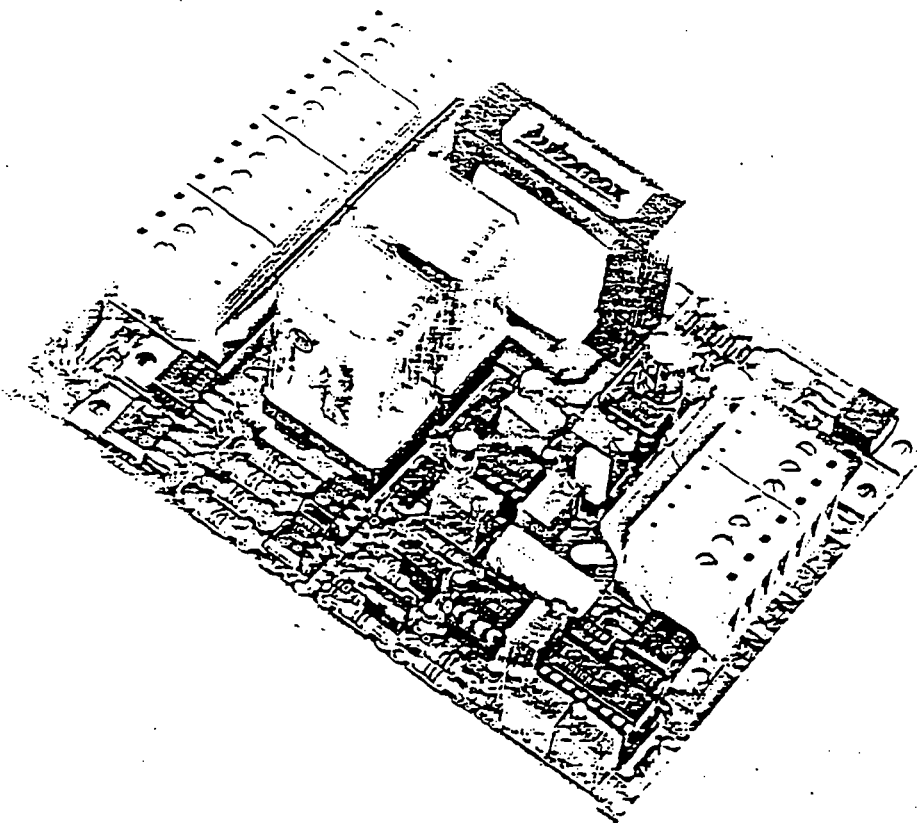
The ESP Electronic Positioner compares the external command signal with a position feedback signal from an internal potentiometer. When the external command signal and internal position signal do not match, the servo amplifier directs the actuator motor clockwise or counter-clockwise until the two signals are equal. As the command signal changes, this process re-occurs, resulting in the correct position.

Compact, Rugged, Internally Mounted

The Automax ESP Positioner has been designed for installation in our E600, 1000, 1500 and 3500. The unit is 5" x 4" x 2" and can also be supplied in a Nema 4 or other enclosure.

Easily Adjustable

Calibration includes separate adjustments for zero, span, deadband, sensitivity, open and close limit switches. LEDs allow for fast, accurate calibration.



SPECIFICATIONS (For Electronics)

VOLTAGES

110-125 VAC, 50 Hz

Input Signals

1 to 5ma DC into 1000 Ohm

4 to 12ma DC into 250 Ohm

4 to 20ma DC into 250 Ohm

0 to 5 VDC

2 to 10 VDC

0 to 10 VDC

Optional Board Required

1.5 to 135 Ohm (Optional Board Required)

1.5 to 1000 Ohm (Optional Board Required)

Position Transmitter (Optional)

4 to 20ma DC

ADJUSTMENTS

Control

Zero

Span

Deadband

Sensitivity

Transmitter (Optional)

Zero

Span

End of Travel Relays (Optional)

1 clockwise (2 contacts independently adjustable NO or NC)

1 counter clockwise (2 contacts independently adjustable NO or NC)

Linearity = 1% span

Resolution = .3% span

Deadband = .25% span

Hysteresis = .5% span

Temperature -40 to 185° F

Power 5W @ 115Vac

Characteristic Linear

Isolation Control to Power Line

1500 V, 10m Ohm

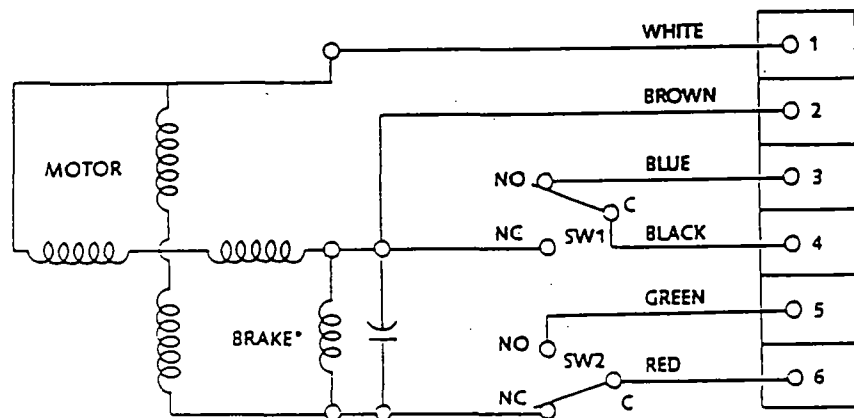
Control to Output

1500 V, 1000m Ohm

Direct or Reverse Acting

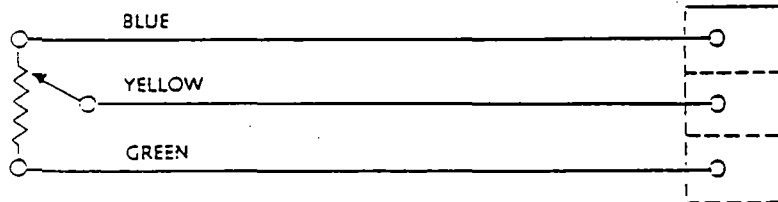
LED Calibration Verification

Standard Reversible Permanent Split Capacitor Actuator with Position & Travel Indicator



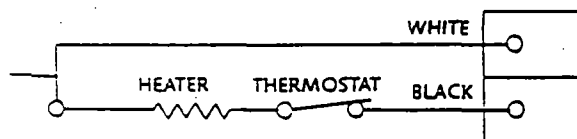
*Brake external to motor on E1000 thru E3500

Potentiometers



Will provide infinite position indication and other feedback functions. 5000 ohm standard, single or dual with other values available.

Heater and Thermostat

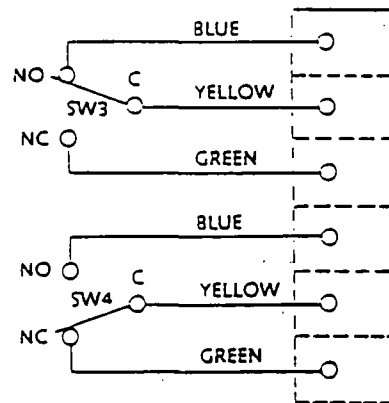


For high humidity or low temperature applications. Will reduce condensation. 25 Watt Heater with thermostat set for 70° F.

Symbols & Descriptions

1. WHITE
Motor Common
 2. BROWN
Travel Indicator
 3. BLUE
Full CW
Position Indicator
 4. BLACK
Power Will Turn Actuator CW
 5. GREEN
Full CCW
Position Indicator
 6. RED
Power Will Turn Actuator CCW
- NO—Normally Open
NC—Normally Closed
C—Common

Extra Switches

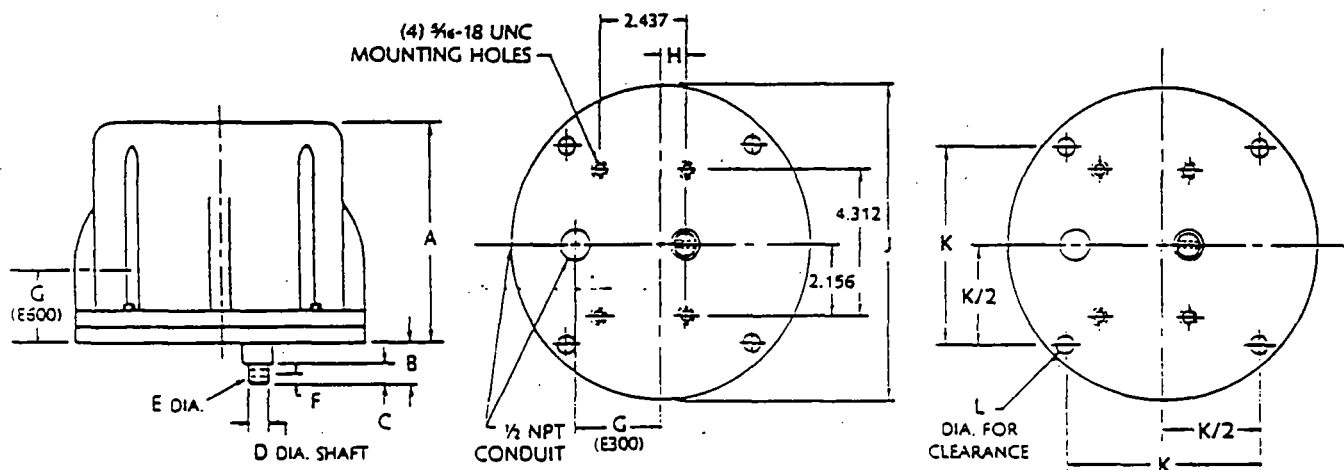


Individual mechanical adjustment will provide independent/isolated electrical control for alarms, lights, motor starters, etc.

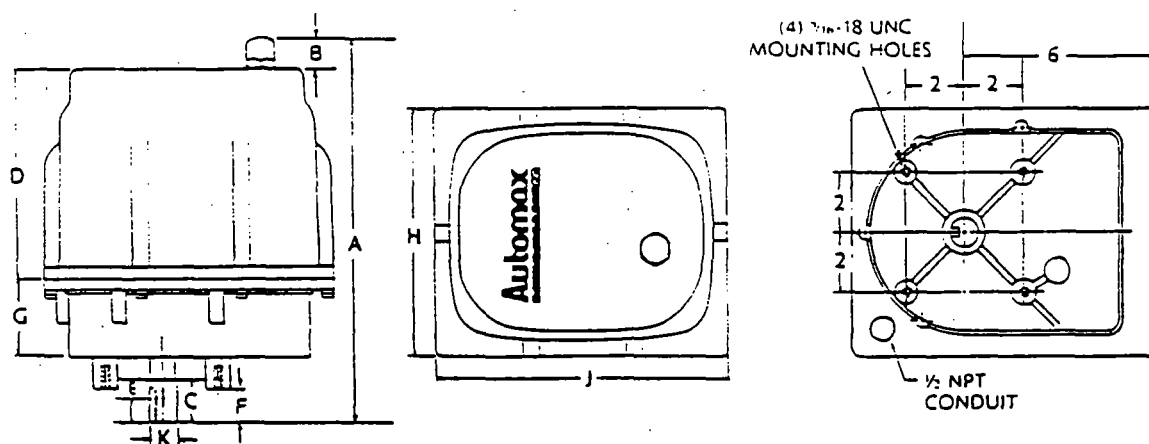
Other Options

- Modulating Controls
ESP Positioner (see page 5)
- Adjustable Speed Controls
- DC Motors
- Shaded Pole Motors
- Unidirectional
- Wiring diagrams for specific applications available, consult factory.

Actuator Mounting Dimensions



Model No.	A	B	C	D	E	F	G	H	J	K	L
E98.6	See E98.6 Bulletin										
E300	5 1/8	1	1/2	1/2	3/16	3/16	2 1/4	2 1/32	7 1/4	4 1/16	3/8
E600	7 1/8	1	—	3/4	3/8	3/8	2 1/4	1 3/8	8 1/4	4 3/8	2 1/32



Model No.	A	B	C	D	E	F	G	H	J	K
E1000, E1500, E3500	12 1/8	1 3/8	1 3/8	7	1/4 x 3/4	1 1/8	2 3/8	8 1/4	10 3/8	1 1/4

Actuators shown in full dockwise (CW) position as viewed from top.

INSTALLATION INSTRUCTIONS

CENTER LINE

RESILIENT OR TEFLON SEATED WAFER VALVES

A. REMOVE VALVE AND OPERATOR FROM ITS SHIPPING CONTAINER, USING CAUTION TO PREVENT ANY DAMAGE TO THE VALVE, VALVE SEAT OR OPERATOR.

B. CENTER LINE RESILIENT SEATED WAFER VALVES MAY BE INSTALLED BETWEEN:

ANSI 125 CAST IRON FLANGES

ANSI 150 STEEL FLANGES, SCHEDULE 40, ALL SIZES

ANSI 150 STEEL FLANGES, SCHEDULE 80, 2"-10" (*)

ANSI 300 STEEL FLANGES, SCHEDULE 40

FLANGE FACES MUST BE FLAT FACE (PREFERRED) OR RAISED FACE.

BEFORE INSTALLING VALVE BE SURE THE FLANGE FACES ARE SMOOTH AND CORRECTLY ALIGNED.

(*) WHEN USING SCHEDULE 80 PIPING THE VALVE MUST BE CENTERED BETWEEN FLANGES TO PREVENT DAMAGE TO THE DISC EDGE WHEN THE VALVE IS OPENED OR CLOSED.

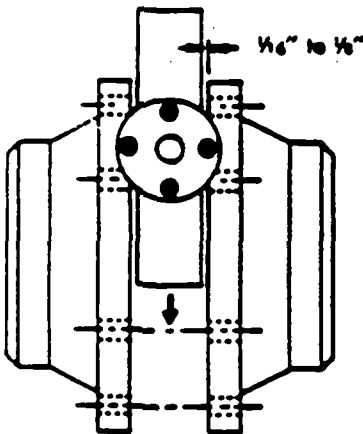
NOTE: WAFER VALVES SHOULD NOT BE MOUNTED BETWEEN DUCTILE IRON FLANGES 14 INCHES AND LARGER (WITHOUT CONSULTING FACTORY).

NOTE: CAUTION - CENTER LINE BUTTERFLY VALVES DO NOT REQUIRE FLANGE GASKETS. USE OF GASKETS MAY BE DETRIMENTAL TO THE SERVICE LIFE OF THE VALVE. THE USE OF FLANGE GASKETS WILL VOID ALL VALVE WARRANTIES.

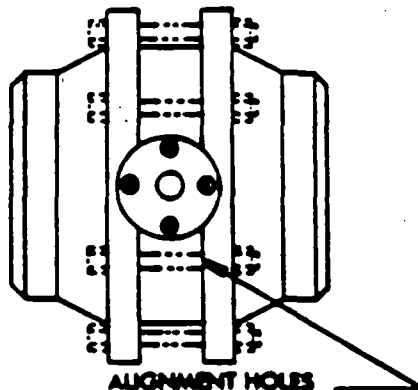
C. INSTALL VALVE BETWEEN FLANGES USING THE ALIGNMENT HOLES IN THE BODY. THRU BOLTS SHOULD BE USED ON NON-LUG TAPPED BODIES. LUG TAPPED BODIES REQUIRE CAP SCREWS FROM EACH SIDE.

D. TIGHTEN FLANGE BOLTS EVENLY AND TIGHTLY.

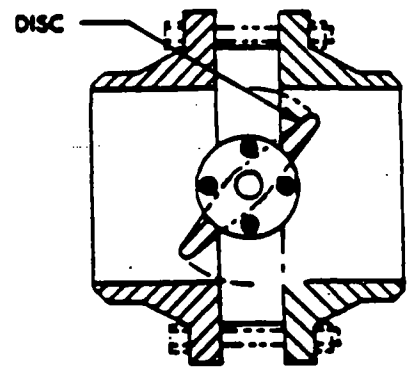
E. ROTATE VALVE TO THE FULL OPEN POSITION (MANUALLY) TO ASSURE DISC CLEARANCE (SCHEDULE 80 PIPING ONLY).



RESILIENT SEATED VALVES REQUIRE 3/16" ADDITIONAL CLEARANCE BETWEEN FLANGES FOR INSTALLATION.



PLACE THE VALVE BETWEEN THE FLANGES USING THE FOUR (4) ALIGNMENT HOLES PROVIDED.



IF OTHER THAN SCHEDULE 40 ANSI 125B, 150B or 300B FLANGES ARE USED, MANUALLY ROTATE SHAFT TO MAKE SURE DISC CLEARS MATING FLANGES AND PIPING. DISCONNECT LINKAGE IF NECESSARY.

REPLACEMENT SEAT

1. REMOVE BOLTS, DISCONNECT LINKAGE & OPERATOR. IF HANDLE VALVE, NO ACTION IS NECESSARY.

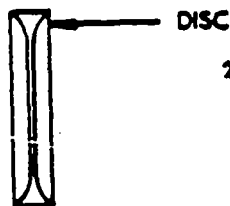
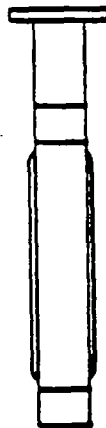
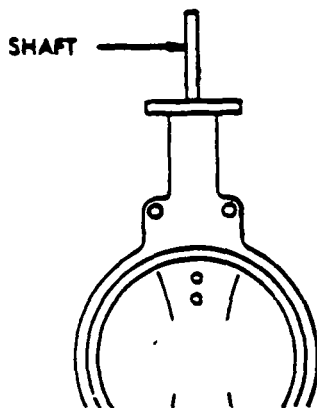
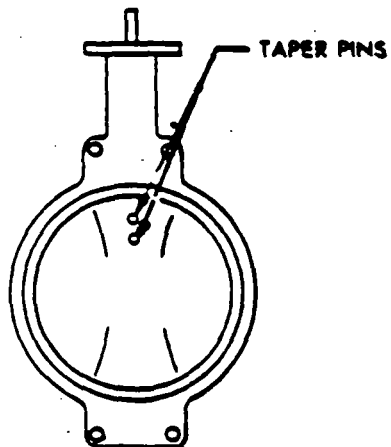
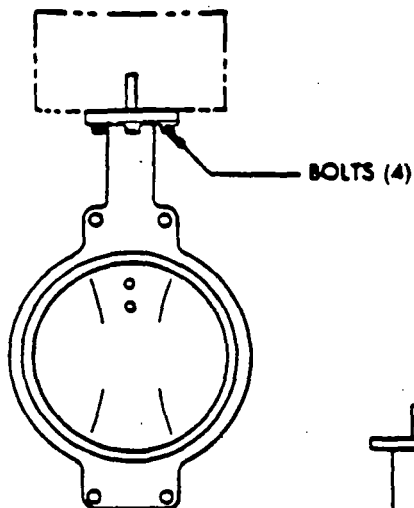
DISASSEMBLE

2. REMOVE TAPER PINS BY KNOCKING OUT SMALL END. USE PUNCH WITH SAME DIAMETER AS SMALL END OF PIN. HIT PUNCH SHARP BLOWS ONCE OR TWICE. DO NOT USE LIGHT TAPS AS THIS WILL PEEN THE TAPER PIN.

3. BY HAND OR OTHER MECHANICAL MEANS REMOVE SHAFT FROM VALVE ASSEMBLY.

4. BY HAND OR OTHER MECHANICAL MEANS, REMOVE DISC. A SLIGHT TWISTING MOTION IS HELPFUL.

5. REMOVE RESILIENT SEAT.

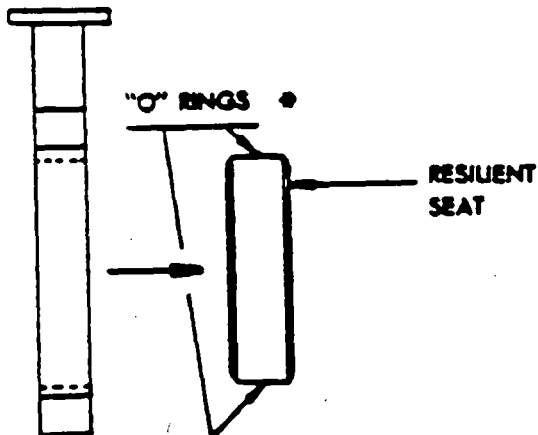


5. REPLACE BOLTS; RECONNECT LINKAGE & OPERATOR. IF HANDLE VALVE, NO ACTION IS NECESSARY.

4. DRILL DISC AND SHAFT AND TAPER REAM, INSERT TAPER PINS. IF USING OLD DISC AND SHAFT, MAKE SURE TAPERED HOLES ARE PROPERLY ALIGNED. TAPER PINS SHOULD GO IN APPROXIMATELY 3/4 DEPTH WITH NO PRESSURE. USUALLY TWO (2) OR THREE (3) SHARP BLOWS WILL SET TAPER PINS.

3. CAREFULLY INSERT SHAFT THRU BODY, SEAT & DISC. AFTER APPLYING SMALL AMOUNT OF LUBRICANT IN TOP SHAFT HOLE.

2. INSERT DISC AND ALIGN BODY, SEAT AND SHAFT HOLE. A SLIGHT TWISTING MOTION IS HELPFUL.



ASSEMBLE

1. INSERT RESILIENT SEAT CAREFULLY. MAKE SURE O RINGS ARE IN SEAT SHAFT HOLE.

*O-Rings not required on newer seats.



ESP ELECTRONIC SERVO POSITIONER

INSTALLATION & OPERATING INSTRUCTIONS

Automax electric actuators with servo control are factory adjusted for 90 degree operation and shipped in the full clockwise position as viewed from the motor side.

WARNING: DO NOT ELECTRICALLY BYPASS ESP BOARD BY CONNECTING POWER DIRECTLY TO MOTOR LEADS WHILE MOTOR IS CONNECTED TO ESP - SERIOUS DAMAGE WILL RESULT AND WARRANTY VOIDED

SERVO CONTROL

1. Connect 115VAC power supply to the terminal marked HI, N, G. Power supply should be fused with a 5 amp slow-blow fuse.

2. Connect input signal to the terminal marked +IN- (factory calibrated to one of the following inputs, 4-20ma is supplied as standard)

- | | | |
|----|------------------|--|
| A. | 4 to 20 ma DC: | Input Jumper on left two posts (Internally 250 Ohm Shunted) |
| B. | 1 to 5 ma DC: | Input Jumper on right two posts (Internally 1000 Ohm Shunted) |
| C. | 0 to 5 VDC: | Input Jumper removed |
| | 2 to 10 VDC: | Input Jumper removed |
| | 0 to 10 VDC: | Input Jumper removed |
| D. | 1.5 to 135 Ohm: | Requires Special Board - Consult Factory. (Connect the potentiometer wiper and one of the other legs to the +IN- terminal location. Disregard polarity with ohm input as it is not important.) |
| | 1.5 to 1000 Ohm: | |

3. ACTION: a) Standard Units are Direct Acting - Low input signal is clockwise and high input signal is counter-clockwise. If this is correct proceed to step 4.

b) To make reverse acting, 1) Drive actuator to the low input signal position and disconnect the motor output terminal block (CCW, N, CW). 2) Switch the Red and Black motor leads, the Green and Blue potentiometer leads, and reset actuator feedback potentiometer for 6.25 volts DC at test point (TP1) (Reset potentiometer on E1000, E1500 & E3500 actuators by loosening bottom two setscrews in helical coupler and turning coupler. On E600 actuators loosen setscrew on gear and turn potentiometer with needle-nose pliers). 3) Both Drive LED's will now be de-energized and the motor output terminal block can be reconnected. Unit is now operational. 4) For position adjustment at the low input signal position turn R11 Zero Adjustment clockwise to operate actuator counter-clockwise. At the high input signal position turn R2 Span Adjustment clockwise to operate actuator counter-clockwise. 5) All CW and CCW notations referring to actuator position are now reversed. (ie CW limit LED is now the CCW limit LED, etc.)

4. Drive actuator full CCW and full CW to check operation and valve port alignment. If adjustment is required proceed with step 5.

5. Deactivate end of travel limit adjustments by turning R12 CCW limit Adjustment clockwise and the R6 CW limit adjustment counter-clockwise two full turns.
6. Drive actuator full CCW. Adjust R2 Span Adjustment to align actuator to required full CCW position. (turn R2 CCW to move CCW).
7. Drive actuator full CW. Adjust R11 Zero Adjustment to align actuator to required full CW position. (turn R11 CW to move CW).
8. Repeat steps 6 and 7 until actuator position repeats at both ends of travel. (usually 2 to 3 times). (NOTE: If while calibrating, the drive LED's energize and the actuator does not respond, check and adjust the safety overtravel limit switch).
9. R26 Deadband Adjustment is factory set for most operating conditions. If actuator is oscillating or is not responsive to small input changes, re-adjust as follows; Drive actuator to mid-position and turn R26 CW until both Drive LED's energize, then immediately turn CCW until both Drive LED's de-energize. Turn adjustment CCW an additional 1/8 turn and operate actuator over the full range to check operation.
10. Drive actuator full CW and adjust R6 CW Limit Adjustment clockwise until the CW Limit LED lights.
11. Drive actuator full CCW and adjust R12 CCW Limit Adjustment counter-clockwise until the CCW Limit LED lights.

INTERNALLY POWERED 4-20T TRANSMITTER (optional)

1. Connect 4-20 ma output leads to terminal marked +TX-.
2. Drive actuator full CCW and adjust R24 (4-20T) Span Adjustment to 20ma output.
3. Drive actuator full CW and adjust R23 (4-20T) Zero Adjustment to 4ma output.
4. Repeat steps 2 & 3 until output repeats.

END OF TRAVEL RELAYS (optional)

1. The End of Travel Relays are set in steps 10 & 11 of Servo Control instructions. The relay is energized when the Limit LED lights.
2. Contacts one (C1, 01) and two (C2, 02) are for the CCW Limit Relay. Contacts three (C3, 03) and four (C4, 04) are for the CW Limit Relay. Relays are Double Pole, Double Throw (DPDT).
3. Each contact can be independently set for Normally Open (NO) or Normally Closed (NC) by positioning the jumper directly behind the contact terminal on either the NO posts (top two) or the NC posts (bottom two).

PROPORTIONAL CONTROLLER (optional)

1. End of Travel Relays and Proportional Controller are mutually exclusive options.
2. Schematic 815070-B for functional details.

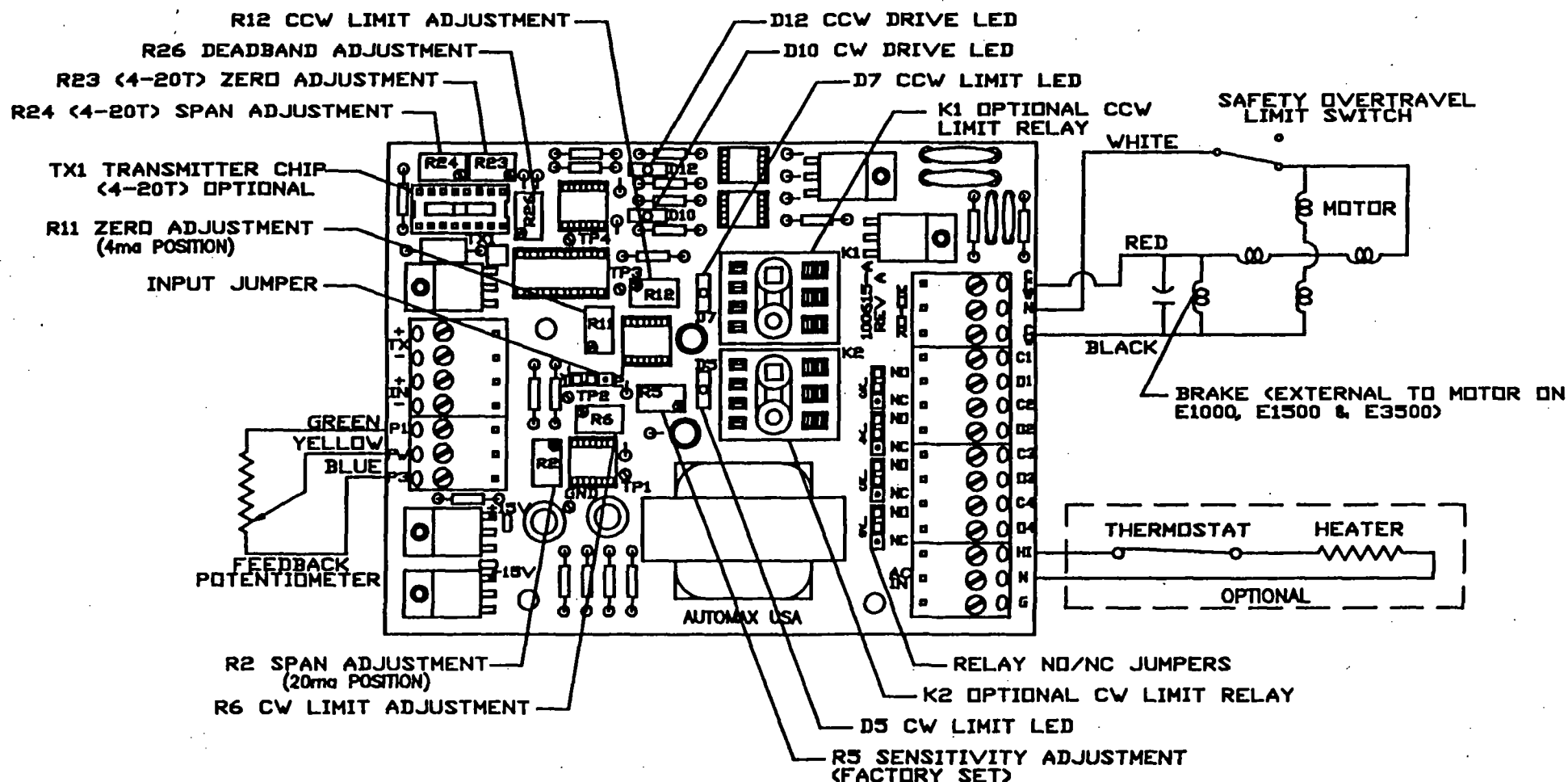
HEATER & THERMOSTAT (optional)

1. 115 VAC Heater and Thermostat are connected to the HI and N terminals of the servo board.



ESP ELECTRONIC SERVO POSITIONER

NOTE: THE SAFETY OVERTRAVEL LIMIT SWITCH DISCONNECTS THE MOTOR IF THE ACTUATOR OVERTRAVELS APPROXIMATELY 5 TO 10 DEGREES PAST THE STANDARD 90 DEGREE STROKE.



WARNING: DO NOT ELECTRICALLY BYPASS ESP BOARD BY CONNECTING POWER DIRECTLY TO MOTOR LEADS WHILE MOTOR IS CONNECTED TO ESP - SERIOUS DAMAGE WILL RESULT AND WARRANTY VOIDED

CALIBRATION INSTRUCTIONS FOR USE W/ DIGITAL VOLT/OHM METER

Refer to instructions on page 1 & 2 for normal final calibration. Procedures listed below are required when ESP is severely out of calibration.

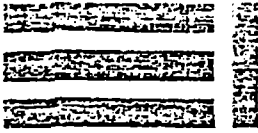
WARNING: DO NOT ELECTRICALLY BYPASS ESP BOARD BY CONNECTING POWER DIRECTLY TO MOTOR LEADS WHILE MOTOR IS CONNECTED TO ESP - SERIOUS DAMAGE WILL RESULT AND WARRANTY VOIDED

- D1. Disconnect motor leads from Automax ESP Servo Board to externally drive actuator.
- D2. Adjust R6 full CCW; R5 full CCW; R12 full CW.
- D3. Connect Power (115VAC) to HI, N & G terminal and with zero input and feedback potentiometer disconnected adjust R11 (Zero Adj.) for zero VDC @ TP3 (To put zero pot in mid-position.)
Note: Connect the meter's BLACK (-) lead to the ground test point labeled "GND" and the RED (+) lead to the numbered test points.
- D4. Adjust R26 (Deadband Adj.) for approximately .05 VDC @ TP4.
- D5. Connect feedback potentiometer and with actuator in full CCW position adjust feedback potentiometer for 6.25 VDC @ TP1.
- D6. Set input @ high input signal (20ma) and adjust R2 (span) for zero VDC @ TP3.
- D7. Position actuator full CW, set input @ low input signal (4ma) and record feedback potentiometer voltage @ TP1 (or return to voltage recorded 1st time thru.)
- D8. Adjust R11 (Zero Adj.) for Zero VDC @ TP3.
- D9. Position actuator full CCW (6.25 VDC @ TP1), set input @ high input signal (20ma), and adjust R2 for zero VDC @ TP3.
- D10. Repeat steps D7 thru D9 until voltage @ TP3 is zero VDC within +/- .050 VDC @ CW/CCW positions.
- D11. Turn power off and connect motor leads to Automax ESP Servo Board. Then turn power back on.
- D12. Position actuator at mid-position (12ma) and adjust R26 (deadband) clockwise until both drive LED's energize. Then turn counter-clockwise until both drive LED's de-energize. Turn adjustment CCW an additional 1/8 turn.
- D13. Position actuator full CW (4ma) and adj. R6 (CW Limit) until CW LED and relay energize.
- D14. Position actuator full CCW (20ma) and adj. R12 (CCW Limit) until CCW LED and relay energize.

Automax
INC.

11444 Deerfield Road
Cincinnati, Ohio 45242
(513) 489-7800
Telex: 241915
Fax: (513) 489-5243

Automax Controls Inc.
2495 Dunwin Drive, Unit 8
Mississauga, Ontario L5L-1T1
(416) 828-0255
Fax: (416) 828-5013



ENGINEERING EVALUATIONS, INC.

7667 Equitable Drive • Suite 202
Eden Prairie, Minnesota 55344
Telephone (612) 937-0121

CARBON AIR SERVICES

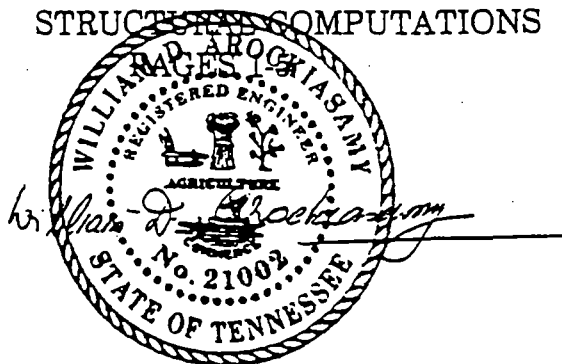
PROJECT NO: #0181SE

AIR STRIPPING TOWER GUYWIRE ANCHORS
COLLIERVILLE, TN.

EEI PROJECT NO. 90-02-A15

REFERENCE: 1. THE BOCA NATIONAL BUILDING CODE 1987.

INDEX: STRUCTURAL COMPUTATIONS



ENGINEER: William D. Arockiasamy

DATE: March 12, 1990

H.W. Cox, Jr., Mayor

H. Tom Brooks, Vice Mayor

John E. Meeks, Register

Jack Everett, Alderman

Jimmy A. Lott, Alderman

Sidney E. Turnipseed, Alderman



Steven H. Schertel
City Administrator

Mary Lee Burley
City Clerk

Town of Collierville

COLLIERVILLE, TENNESSEE 38017

RECEIVED
MAR 9 & 1990
CarbonAir Services, Inc.

Carbonair
P.O. Box 5117
Hopkins, Mn. 55343-1117
Attn. Robert E. Clifford, III

re: Earthquake requirements for Collierville, Tn.

Dear Mr. Clifford,

After our meeting of March 6, 1990, I discussed your question about earthquake design for the air strippers at our water plant #2 with Betty Watson, Building and Codes Director for the Town of Collierville. Mrs. Watson advised that at this time seismic design requirements have not been adopted and seismic design would not be a code requirement.

It is my feeling that due to the time constraints and the fact that design criteria are not in place that seismic design will not be required for this project.

If you have any further questions, please contact me.

Sincerely,

James Mathis
Director of Public Utilities

1. ANCHOR WEIGHT:

Up Lift $T_u = .75 \times 1.7 \times 1850 = 2359^*$

Use Concrete block 3' DIA \times 3'-6" HIGH.

Dead Load Resistance $= .9 \times T \times \frac{1}{2} \times 3.5 \times 144$

$= 3206^*$

$> T_u = 2359^* \therefore \text{OK.}$

2. Guy wire:

Use $5/16"$ DIAM. 6x7 Std. Coarse Laid Rope.

Breaking strength $= 3.1 \text{ TONS.}$

Using a FS of 2 Allowable Load $= 3100^*$

Allowable Load for wind $1.33 \times 3100 = 4123^*$

Actual tension on rope $= 2490^*$
 $< 4123^* \text{ OK.}$

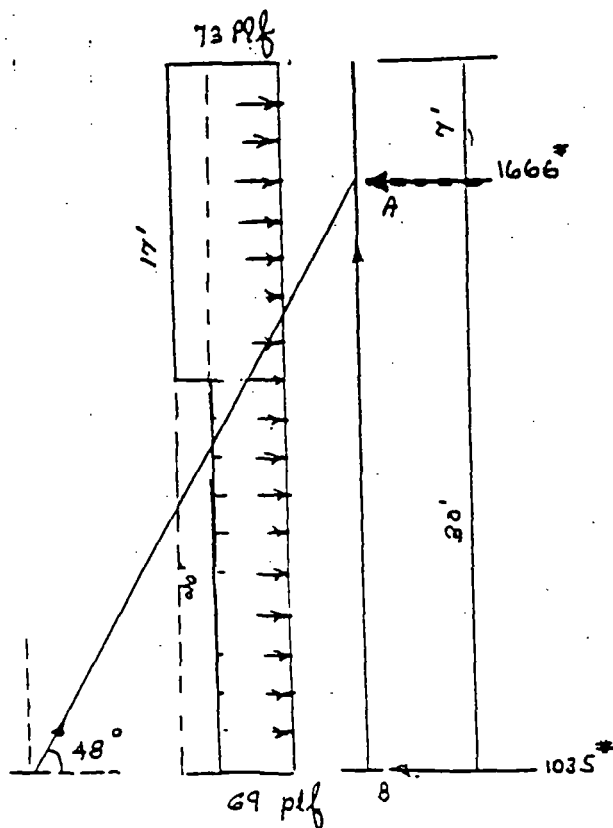
3. HORIZ. LOAD ON SOIL:

MAX. HORIZ. Load $= 1666^*$

Neglecting Top $1\frac{1}{2}$ ft. of Soil.
Passive resistance required from Soil $= \frac{1666}{3' \times 1.5} = 370 \text{ PSF}$

Soil is assumed to provide this resistance.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



Assume 5' DIA of Tower
for full height

$$\therefore \text{Wind load on Tower}$$

$$\begin{aligned} \text{for } 0'-20' &= 13.73 \times 5 = 69 \text{ plf} \\ 20'-40' &= 46.66 \times 5 = 73 \text{ plf} \end{aligned}$$

Using a Uniform load of 73 plf for full height.
HORIZ. REACTION @ A = 1666#

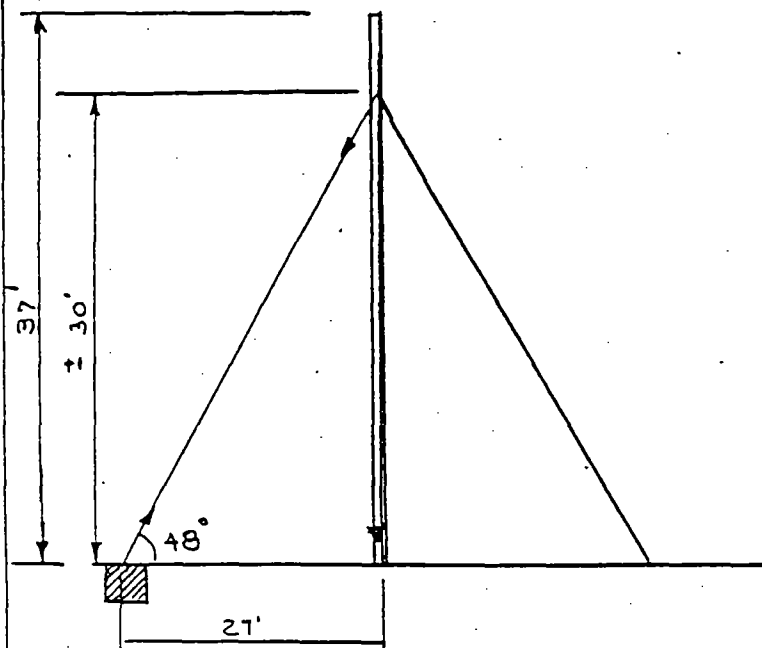
$$B = 1035\#$$

$$\begin{aligned} \text{Tension in Guy wire} &= \frac{1666}{\cos 48^\circ} = 2490\# \\ \text{Vertical uplift on anchor} &= 2490 \times \sin 48^\circ = 1850\# \\ \text{HORIZ. LOAD ON ANCHOR} &= 1666\# \end{aligned}$$

GUY WIRES:
AIR STRIPPER TOWER

CARBON AIR SERVICES
COLLIERVILLE, TN.
MARCH 9, 1990
WJA.

Sheet # 2



DIAMETER OF TOWER = 60" = 5'-0"
(Assumed uniform for full height).

WIND LOADS PER "BOCA BUILDING CODE"

BASIC WIND SPEED = 70 MPH.

Design Wind Pressure $P_d = P_e \times I^2 \times C_p$. $I = 1.07$ for Category II

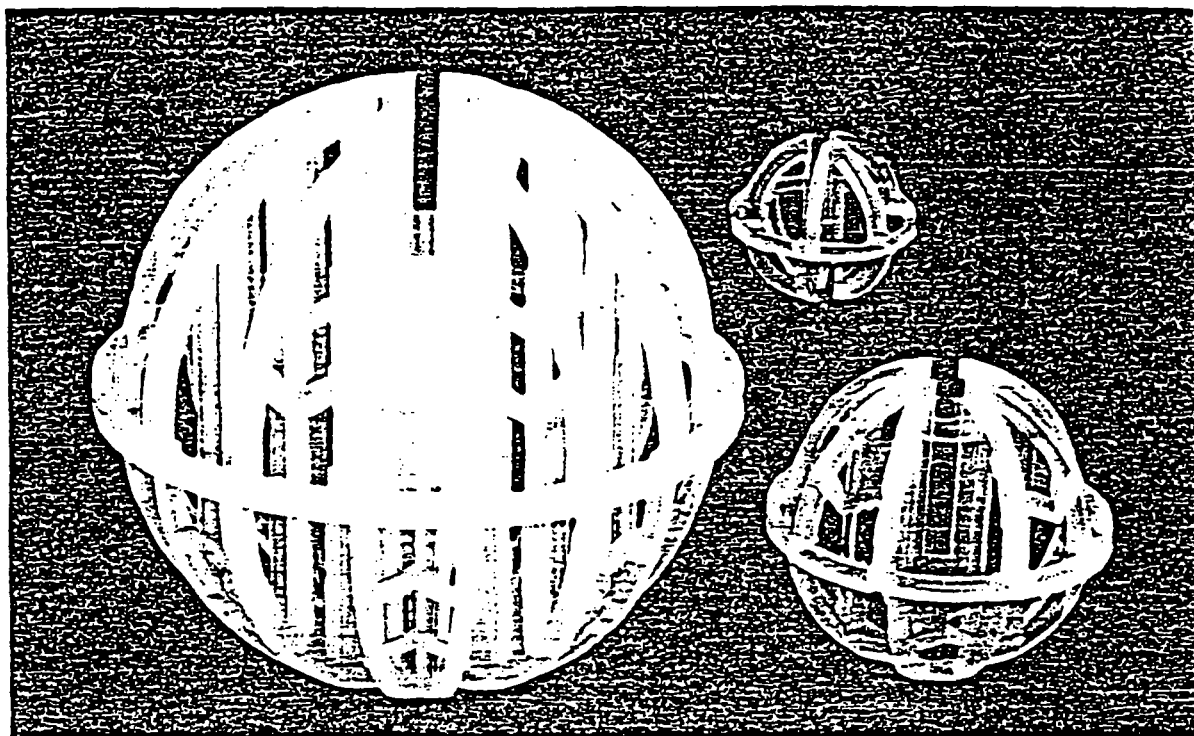
FOR EXPOSURE "C" P_e for 0'-20' = 15 PSF
20-40 = 16 PSF

$2\sqrt{P_e} \leq 20$ FOR ROUND $2\sqrt{P_e} \geq 2.5$ $\frac{h}{D} = \frac{37}{5} = 7$ $C_p = .8$

$\therefore P_d = P_e \times 1.07^2 \times .8 = .916 P_e$
= 13.73 PSF for heights 0'-20'
= 14.66 PSF " 20'-40'

PLASTIC JAEGER TRI-PACK

High performance column packing



FEATURES

Plastic Jaeger Tri-Packs® is a hollow, spherical-shaped packing made of injection molded plastic in three sizes: 1", 2" and 3½" diameter. Its symmetrical geometry made from a unique network of ribs, struts and drip rods yields unprecedented performance. It has high void space, greater than packings of comparable size, and achieves superior pressure drop values, up to 90% reduction, as compared to other products. The packing has a high ACTIVE surface area, exposing all of its surface area to be fully wetted during column operation. The performance capabilities of plastic Jaeger Tri-Packs® have resulted in significant savings in hundreds of packed column operations.

BENEFITS

- Highest mass and/or heat transfer rate
- Extremely low pressure drop
- Free of plugging, fouling, nesting and wall channeling
- Highest flooding point and low wetting point
- Even gas and liquid distribution
- No interlocking or meshing
- Used as a mist eliminator

PLASTIC JAEGER TRI-PACKS®

SPECIFICATIONS

Materials. Nine standard, injection moldable plastics are available:

Polypropylene (PP)	Kynar® (PVDF)
Polyethylene (PE)	Halar® (ECTFE)
Polypropylene	TopEx (LCP)
Glass-Filled (PP-G)	Tefzel® (ETFE)
Noryl® (PPO)	Teflon® (PFA)

Others are available on request.

Sizes. Plastic Jaeger Tri-Packs® packings are made in three sizes:

No. ½...	1" Nominal
No. 1...	2" Nominal
No. 2...	3½" Nominal

PHYSICAL PROPERTIES

Type	No. ½	No. 1	No. 2
Size	1"	2"	3½"
Geometric Surface Area (ft²/ft³)	85	48	38
Packing Factor (1/ft)	28	17	12
Void Space (%)	90	93	95
Weight (lb/ft³)	6.2	4.2	3.3

MASS TRANSFER DATA

Absorption System	G (lb/hr-ft²)	L (lb/hr-ft²)	Temp. (°F)	HTU - Inches	
				2" & 3½"	1"
HCl-H₂O	1792	2048	77	10.6	7.0
HCl-NaOH	1567	2048	68	8.8	6.1
Cl₂-NaOH	1229	2202	122	14.5	9.9
NO₂-Na₂S+NaOH	717	1127	68	49.2	32
NH₃-H₂SO₄	492	1024	68	6.0	4.1
NH₃-H₂O	512	1024	68	8.4	5.6
NH₃-H₂O	512	4096	68	5.4	3.6
SO₂-NaOH	1946	4096	140	12.0	8.1
HF-H₂O	1844	3072	77	6.9	4.6
CH₃COCH₃-H₂O	1700	860	68	15.2	10.2
H₂S-NaOH	1229	1331	68	19.4	13.0

JAEGER TRI-PACKS® is a Trademark of JAEGER PRODUCTS, INC. U.S. Patent No. 4,203,935. Canadian Patent No. 1,150,621. Tri-Packs have the Trademark "HACKETTEN" in Germany. Further Patents pending.

Other Trademarks herein:

Noryl® ... General Electric Company
 Kynar® ... Pennwalt Corporation
 Halar® ... Allied Chemical Co.
 Tefzel® ... E.I. DuPont de Nemours & Co., Inc.
 Teflon® ... E.I. DuPont de Nemours & Co., Inc.

VOC Stripping	G (lb/hr-ft²)	L (lb/hr-ft²)	Temp. (°F)	HTU - Inches	
				2"	1"
TCE(ppm)-H₂O	479	12264	77	26.9	21.5
TCE(ppm/ppb)-H₂O	690	12494	60	37.6	30.1
BTX(ppb)-H₂O	722	4998	70	39.2	31.4

Superior performance by design
JAEGER PRODUCTS, INC.

Marketed by: "

POLYMER PIPING & MATERIALS
 P.O. Box 16117, Houston, Texas 77222
 (713) 672-4200, Telex 79-0119
 TX WATTS 800-833-8483
 U.S. WATTS 800-231-0146

Represented by:



JAEGER PRODUCTS, INC.

HIGH PERFORMANCE TOWER PACKINGS
AND COLUMN INTERNALS

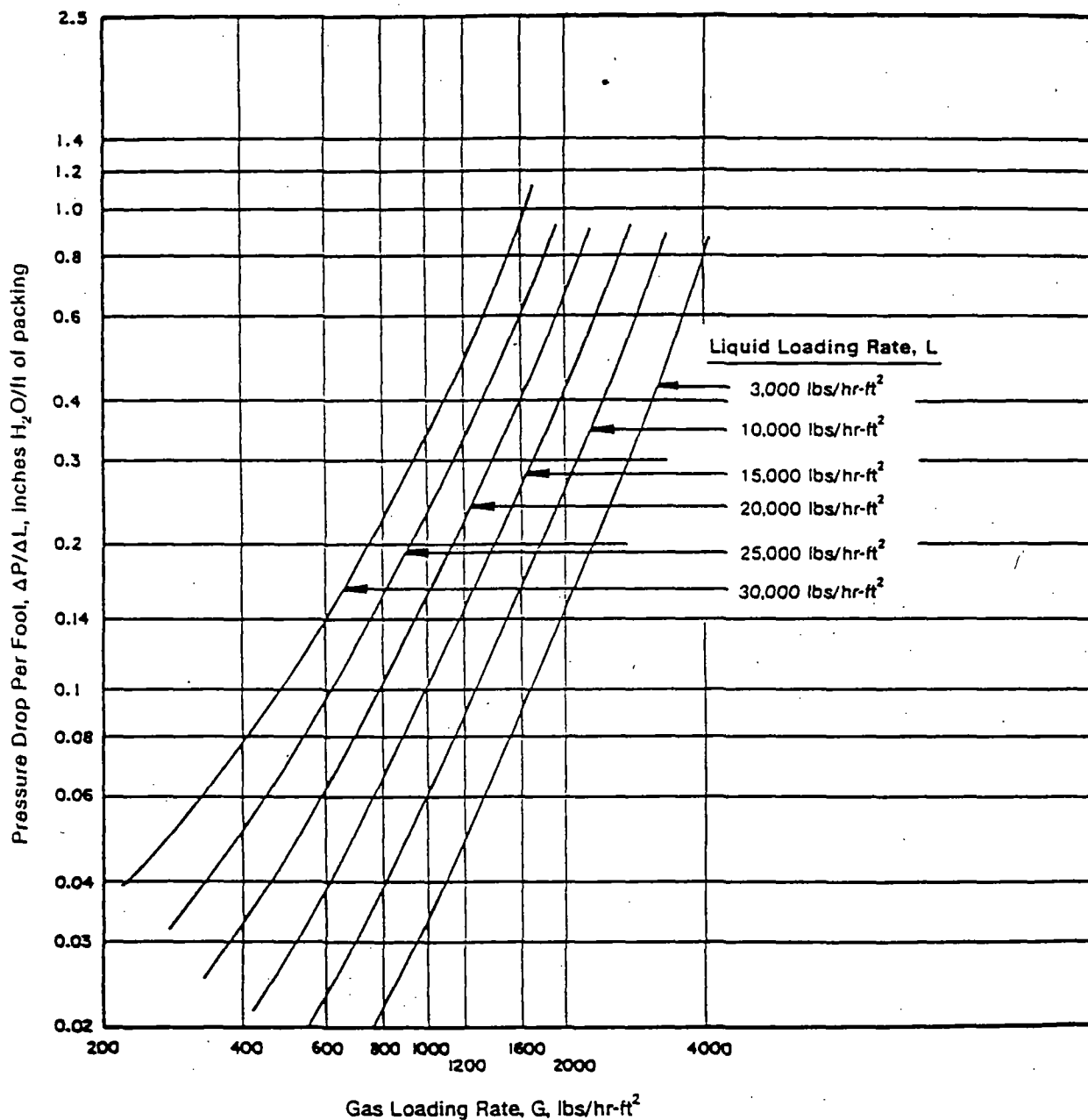
P.O. BOX 1563
SPRING, TX 77383

(713) 353-4700
TELEX 98-9992

PRODUCT DATA PD-605

PLASTIC JAEGER TRI-PACKS®

Pressure Drop of 3½" Plastic Jaeger Tri-Packs® Air-Water System, 1 atm, 70°F



MARKETED BY:



Polymer Piping and Materials

4730 Darien, P.O. Box 16117, Houston, Texas 77222
Phone 713-672-4200, Telex 79-0119, Fax 713-672-4383
U.S. 1-800-231-0146, TX 1-800-833-8483

REPRESENTED BY:



JAEGER PRODUCTS, INC.

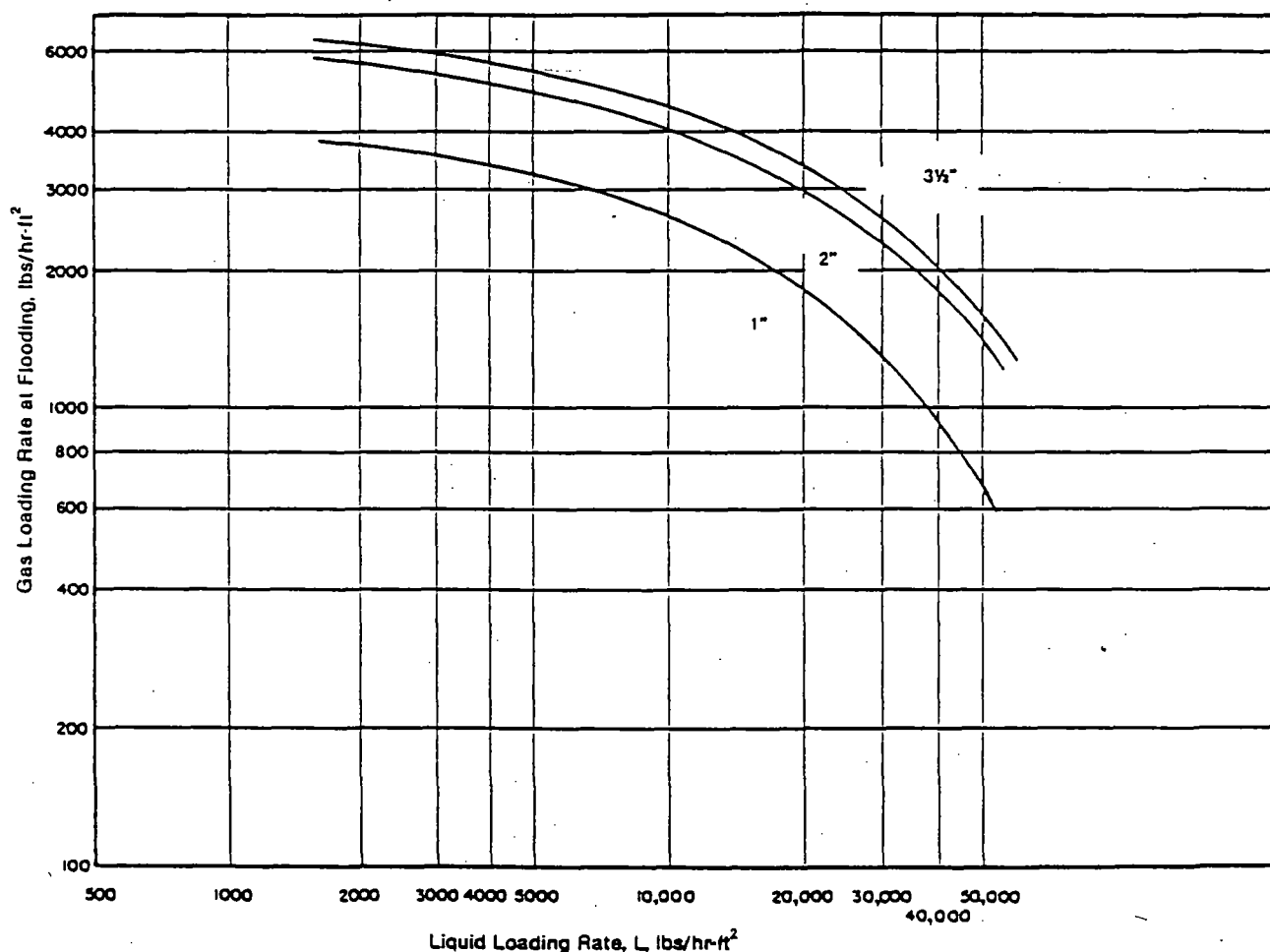
HIGH PERFORMANCE TOWER PACKINGS
AND COLUMN INTERNALS

P.O. BOX 1563
SPRING, TX 77383

(713) 353-4700
TELEX 98-9992

PRODUCT DATA PD-607
PLASTIC JAEGER TRI-PACKS®

Flooding Points of Plastic Jaeger Tri-Packs®
Air-Water System, 1 atm, 70°F



MARKETED BY:



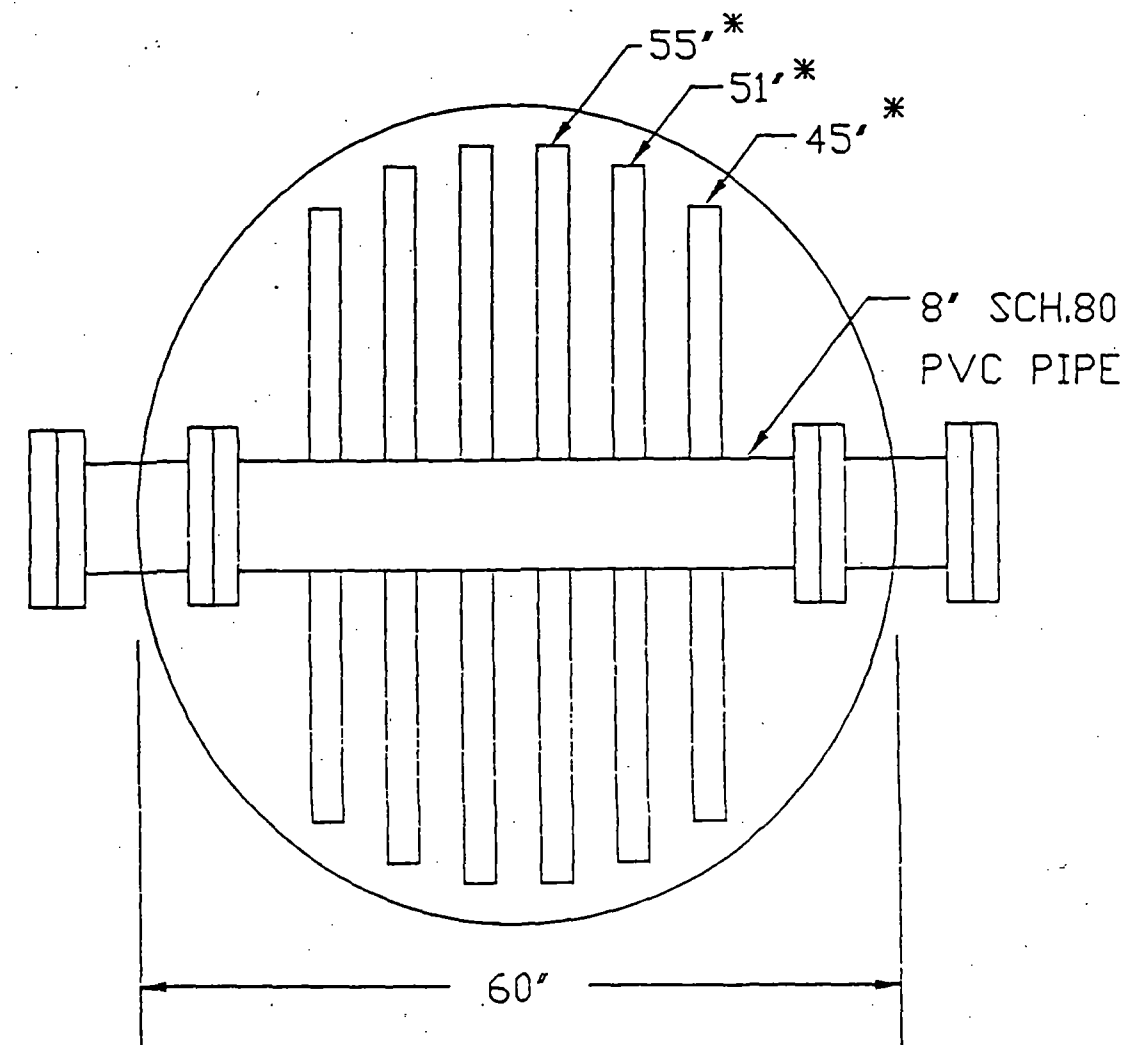
Polymer Piping and Materials

4730 Darien, P.O. Box 16117, Houston, Texas 77222
Phone 713-672-4200, Telex 79-0119, Fax 713-672-4383
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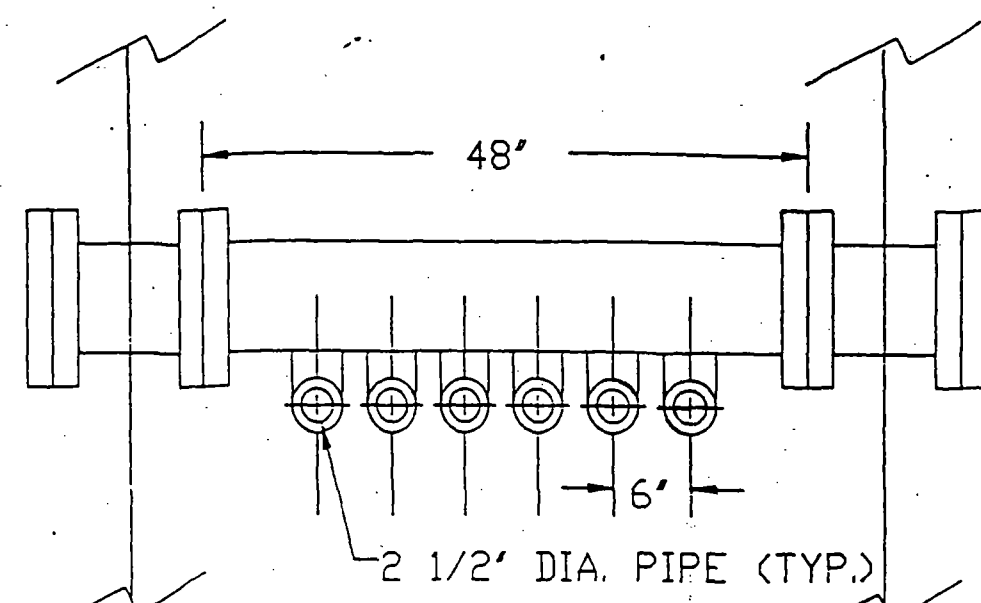
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PART NUMBER

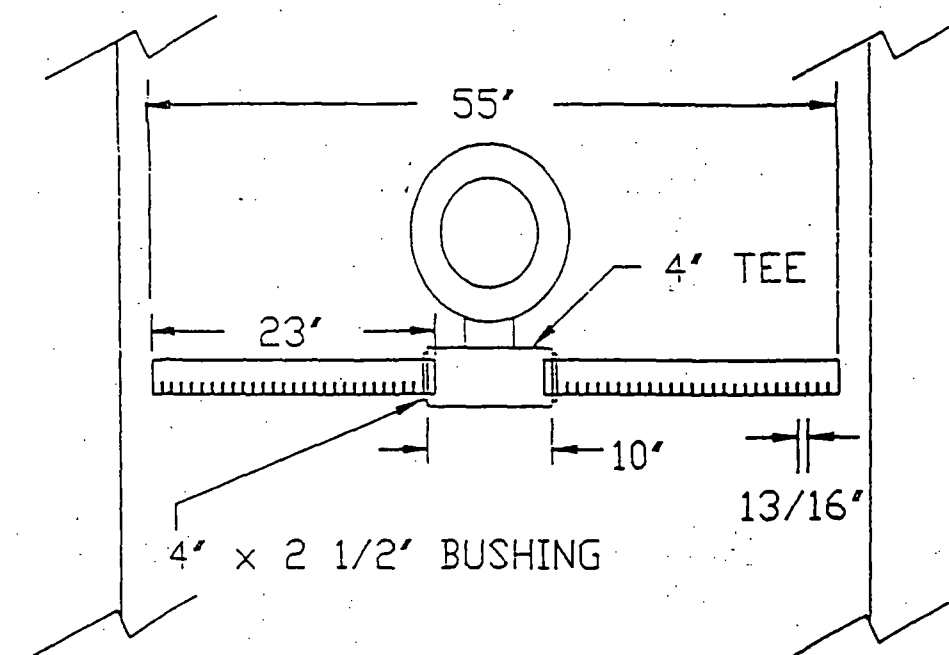
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED



TOP VIEW



FRONT VIEW



SIDE VIEW


* The lateral lengths given are total length, including tee.

All dimensions are in inches.

The laterals have one slot every 13/16".

The width of the slot openings is 1/8".

The length of the slot is 120° of the pipe circumference.

MATERIAL UNLESS NOTED OTHERWISE			APPROVAL	DATE	 CARBONAIR WATER AND AIR DECONTAMINATION MINNEAPOLIS, MINNESOTA
SCH.80 PVC			DRY	05/17/90	
TOLERANCES UNLESS NOTED OTHERWISE			DRY		
DECIMAL	FRACTIONAL	ANGLES	DRY		TITLE
.03	1/32"	1°	DRY		COLLIERVILLE DISTRIBUTOR
THESE MATERIALS ARE CONFIDENTIAL AND ARE THE PROPRIETARY INFORMATION OF CARBONAIR SERVICES, INC. AND MAY NOT BE USED OR REPRODUCED WITHOUT THE CONSENT OF CARBONAIR SERVICES, INC.			THIRD ANGLE PROJECTION		SIZE C
			UNLESS OTHERWISE SPECIFIED:		DWG. NO. CC516
			• DIMENSIONS ARE IN INCHES		SCALE
			• DO NOT SCALE DRAWING		DRUP. NO.
					SHEET 1 OF 1

GEMS® LIQUID LEVEL SWITCHES MULTI-STATION

GEMS FABRI-LEVEL Switch Kits

GEMS FABRI-LEVEL units can be custom-assembled in minutes from standard components, right in your plant. Simple instructions are furnished with kits.

FABRI-LEVEL Switch Kits contain all components for complete assembly of a 1- or 2-station level switch unit for pipe-plug mounting in your tank. N.O. or N.C. operation of the SPST switch is selectable by inverting the float(s) on the unit stem. Two 10" (254mm) lengths of tube are furnished to space level stations as desired. Other components available for custom-building other configurations are listed at right.

Specifications . . .

	Brass/Buna N	All 316 SS
Ambient Temp. (Oil)	-40° to +230°F.	-40° to +275°F.
(Water)	to +180°F.	to +275°F.
Pressure Rating (Max.)	150 psi	750 psi
Float Sp. Gr.	.55	.65
Fitting Ferrule Material	Nylon	316 SS
Mounting Thread	1 1/4" or 2" NPT-M	
Conduit Thread	1/2" NPT-F	
Tube/Fitting Size	1/2" (12.7mm) o.d. tube	
Max. No. Levels per Stem	6	
Mounting Attitude	Vertical ± 30°	
Switch—See Elec. Data, P. 3	SPST 20 VA	

Each FABRI-LEVEL Kit listed below contains:

- 1 Tube Connector
- 1 Mounting Plug
- 2 Level Stations (Switch, Tube, Float)
- 2 Extension Tubes
- 1 Tube End Fitting
- 3 Tube Unions

Standard FABRI-LEVEL Switch Kits . . .

Mtg. NPT	Material	Kit No.
2"	Brass Fittings; Buna N Floats	24576
1 1/4"		26128
1 1/4"	Stainless Steel Fittings, Buna N Floats	26130
2"		26675
2"	All 316 SS Stainless Steel	24577

GEMS FABRI-LEVEL Components

LEVEL STATION:

Float/tube/switch assy. Choice of Buna N or 316SS float, brass or 316SS tube. SPST switch with #18 awg wires or SPDT switch with #22 awg wires. Teflon lead wires 60" L.

For Mtg. Plug Size	Float Mat.	Switch	P/N		Tube Dia.
			Tube Mat.		
			Brass	316SS	
1 1/4" NPT	Buna N	SPST	26609	26608	4.00"
		SPDT	26737	26738	4.45"
2" NPT	Buna N	SPST	24410	25328	4.00"
		SPDT	24578	25329	4.45"
	316 SS	SPST	—	24411	4.25"
		SPDT	—	24579	4.45"

MOUNTING PLUG: Provides clearance for inserting unit in tank.

1 1/4" NPT: Brass— P/N 26034 316SS— P/N 26033

2" NPT: Brass— P/N 24408 316SS— P/N 24407

TUBE CONNECTOR, 1/2": Connects tube to mtg. plug, mounts unit from inside of tank. Brass—P/N 24633; 316SS— P/N 24634

TUBE UNION, 1/2": Connects level stations or extension tubes. Brass—P/N 24412; 316SS— P/N 24413

TUBE END FITTING, 1/2": Seals end of unit. Brass—P/N 24553; 316SS— P/N 24554

BULKHEAD ADAPTER 1/2": For top or side entry (with 90° elbow) into tank. Brass—P/N 24635; 316SS— P/N 24636

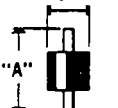
90° ELBOW, 1/2": for side entry into tank (with bulkhead adapter). Brass—P/N 24631; 316SS— P/N 24632

TUBING: 1/2" (12.7mm) O.D. For extending units or level station spacings.
10" long: brass—P/N 25199; 316SS— P/N 25204
36" long brass—P/N 24637; 316SS— P/N 24638

Ordering Information . . .

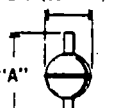
When ordering kits, specify kit number(s) required. When ordering components, specify part numbers (P/N) and quantities of each required.

1 1/4" (Ref. 1 1/4" NPT Plug) or 1 1/4" (Ref. 2" NPT Plug)



BRASS—BUNA N

2 1/8" (53.9mm)



ALL 316 SS

1/2" NPT-F



1-1/4" (31.7mm)

1-1/2" (38.1mm)

3/8" NPT-M

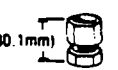


1 3/4" (44.4mm)

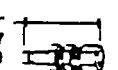
2 1/8" (53.9mm)



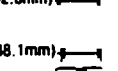
1 3/8" (30.1mm)



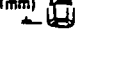
3 1/8" (77.7mm)



1 1/8" (42.8mm)



1 1/2" (38.1mm)



1 1/2" (38.1mm)



1 1/2" (38.1mm)

Appendix D

**Reserved: to be submitted when made available from
Town of Collierville**

Operation and Maintenance Plan — Water Plant 2